POWER

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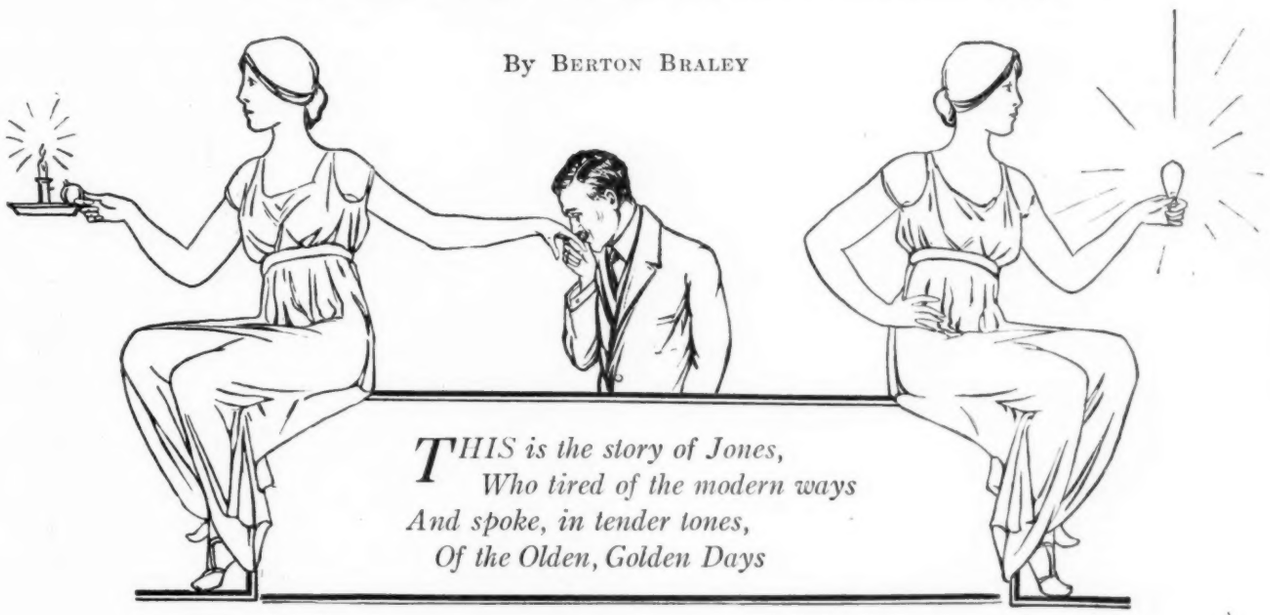
When the Power Was Off

By Berton Braley



THIS is the story of Jones,
Who tired of the modern ways
And spoke, in tender tones,
Of the Olden, Golden Days

IT was seven o'clock of a wintry morn that Jones arose from bed,
And he turned the switch, but no lights came on from the sockets overhead;
And he stumbled along in the early gloom and muttered in rage and wrath
When he found that the spigot wouldn't flow and he'd have to forego his bath.
So he dressed, unwashed, in the dismal dark, then he went to the telephone,
But there wasn't a sound on the silent wire to answer his angry tone,
So he rushed at once to his frugal meal which he'd bade the cook prepare,
But the gas was off in the kitchen stove and his breakfast wasn't there.

He grabbed some fruit from the pantry shelf and jammed his hat on his head,
But he looked in vain in the chilly hall for the paper he always read,
And with muttered oaths he made his way to wait for his trolley car,
But there wasn't a single one in sight, though he looked for 'em, near and far.
With a temper near to the boiling point and thoughts that were full of murk,
He plodded along in the snow and slush three weary miles to work,
And never a car or a taxicab or a limousine saw he,
Wherever he looked the people walked—and few of them walked in glee.

At last he came to the office block where he did his daily chore
At a roll-top desk in a suite of rooms way up on the fortieth floor,
But the weary Jones grew wearier still and his face was the hue of chalk
When the starter told him, "The power's off, an' I reckon you'll have to walk!"

He climbed and clambered those endless stairs until he could scarcely creep,
And when he came to his office door he fell in a senseless heap;
He had reached his work, he was on the job, but alas, when he came to,
He found that the journey was all in vain, there was no work to do.

For the mails had stopped and the 'phone was dead and the ticker wouldn't go,
And the lights were out and the steam was off and the mercury was low,
And nobody came to the office door, for nobody cared to climb.
So Jones just sat at his office desk and fretted till luncheon time,
But he got no food at the restaurant, and all in vain he called,
For the freight trains bringing the food supply were all tied up or stalled,
Mechanical power had ruled his life, had toiled for him, night and day,
And he was lost in an unknown world when the power was taken away.

He was back in the midst of the Good Old Days he had sighed for now and then,
And he loudly swore that nevermore would he wish for them again.
He laid a curse on the Good Old Days—and straight from the heart he spoke—
He blessed the times when the power was on and then, and then—he woke
To turn the switch and to light his room, to hear the sizzling steam
That came from the radiator valve—and say, "It was a dream
Only a dream of a powerless world, and here, in my cosy flat,
I wake to find that the power is on and to say, 'Thank God for that.' "

Weighing Coal at Power Plants

By Henry J. Edsall

SYNOPSIS—The value of coal-weighing machines is shown for checking up the amount of coal received, for giving a record of the amount used and for weighing the coal consumed by each individual unit. The operation of several types of weighing scale is described.

Equipment for weighing coal at power plants might be divided into three classes—that for weighing the coal received, that for weighing the total amount of coal consumed and that for weighing the coal consumed by each boiler unit. The primary object of the first is to check up the amount of coal received, so that the purchaser can see whether he is getting what he pays for. The second class of equipment is for keeping a record of the quantity of coal used so as to know what the requirements are for the future, also to see whether the boilers are operating at about their proper efficiency. The record of the total amount consumed by several units will not give an accurate idea of the efficiency of each unit. The third class of equipment is used to get a record of the operation of each unit. In some cases two or more boilers are grouped together and each group should be taken as one unit.

A consumer may have confidence in the people from whom he purchases coal, but discrepancies will occur at times through errors in weighing, losses in transit or other causes that are usually beyond the control of the shipper or dealer.

If an equipment is installed to weigh the coal as it is consumed and provision is also made for keeping a record of the amount of water used or steam generated, it shows what results are being obtained from the coal used; and if these results vary from time to time, an investigation as to the cause can be made and the faults corrected as far as possible or as far as expenditure for the improvement to be gained is justified.

Fuel is the largest single element in the cost of power, and economy in its use is the most important factor in keeping down that cost. By trying out various classes of coal and keeping a record of the quantities used and the cost to generate a certain amount of power, the most suitable kind can be selected for the particular conditions at a certain plant. In order to make such records of real value, they must be carried along continuously under regular operation, and conditions of draft, flues, variation of load, etc., noted so that proper comparisons can be made. Purchasing coal on the B.t.u. basis is becoming more popular, and while the determination of the number of B.t.u. is made by analysis, this determination should be checked by records of the amount of coal used and the results obtained under actual operating conditions.

For checking the amount of coal received at a plant, there are several types of equipment used, such as track scales, wagon scales, weighing hoppers with hand-operated or automatic scales, conveyor weighers and coal meters. For determining the quantity of coal used each day in a boiler room the same types of weighing or measuring devices may be used and also the movable weighing hopper or traveling larry equipped with some kind of scale.

For keeping a record of the coal used in each separate unit, the devices ordinarily employed are the automatic scale or coal meter, one of which is usually fitted to the spout or spouts supplying each unit. It is possible to weigh the coal used in each unit by means of a movable weighing hopper equipped with a hand-operated or automatic scale, but in this case it is necessary to depend on an attendant to keep the amounts for each unit separated from those for the others, and it is next to impossible to get men who will always keep their records properly separated. If these records are to be dependable, the human element must be eliminated and they must be made entirely automatically and without any possibility of error through carelessness or intent.

Track scales are set in the car track so that a section of the rails is carried by the scale platform and the rail-

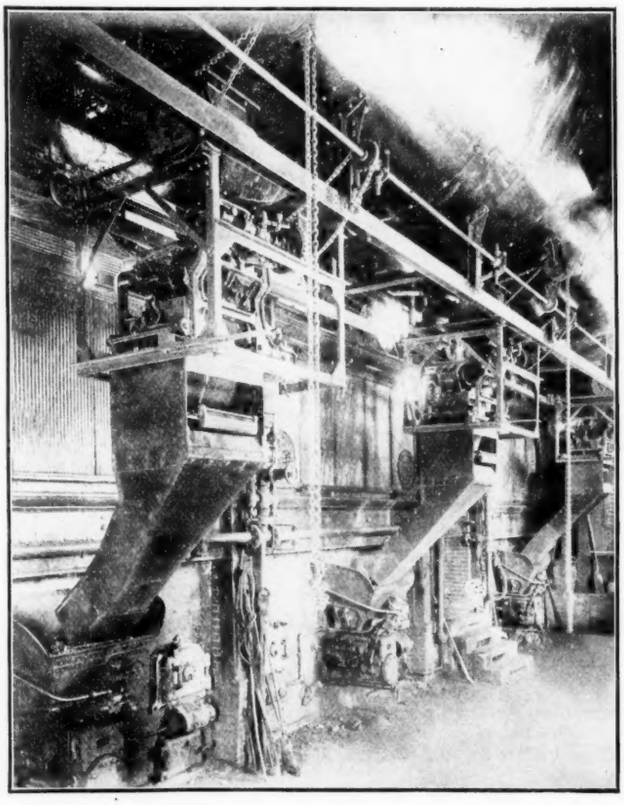


FIG. 1. INDIVIDUAL 100-LB. AUTOMATIC SCALES

road cars can be run upon the platform and weighed. The wagon scale is similar. In some cases the coal is handled in small hand-operated industrial cars, automatic railway cars or cars operated by electricity or a cable system. It is feasible to provide track scales to weigh the coal handled by such cars, and if the amount handled justifies the expense, scales can be used that will automatically record the weight as the car passes over the scale platform without stopping. The recording device of one of these scales consists of a wheel having the numbers in type on its periphery, and when a lever is moved by the attendant or is tripped automatically as the car passes over the platform,

the wheel revolves a certain distance depending on the weight and then prints the amount on a tape which is fed from one roller and wound up on another. The weights of the different loads are thus recorded on the tape, which can be taken off whenever desired.

Track scales are also used for overhead tracks, usually of the monorail type. In such cases a separate section of rail or rails is supported on the scale beam so that the larries or trolleys carrying the loads can be stopped and weighed; or if an automatic recording scale is installed, the loads can be weighed as they pass over this section of track.

Automatic coal scales are becoming popular, as they eliminate the labor and the possibility of error of the human element, the recording of the weights being done by the mechanism of the scale. These machines consist essentially of some kind of device for feeding the coal into a weigh hopper and arranged so that the feed will be shut off just at the instant when the hopper is filled to the proper amount; that is, if the scale is of 500-lb. capacity, coal will feed into the hopper until it contains exactly 500 lb., when the feed will be automatically shut off and another gate at the bottom of the hopper automatically opened, so that the 500 lb. in the weigh hopper will be discharged, providing there is sufficient space underneath. Then the lower gate is automatically closed and the feed again started to fill the hopper up with another 500-lb. load. Each load is recorded by an automatic counter, so that the number of loads which have passed through the hopper can be read at any time. If there is not space enough underneath the weigh hopper for the coal to discharge immediately, the mechanism remains inactive until the coal underneath is removed sufficiently so that the weigh hopper can discharge completely; then the lower gate closes and the feeding mechanism starts once more. These automatic scales can be placed underneath a receiving hopper into which the coal is dumped from wagons or cars, or, as is usually the case, they can be placed somewhere in a conveyor system so that the coal can be handled from one conveyor through the weighing hopper and weighed before it passes on to another conveyor. In this way an accurate record can be obtained of the amount of coal passing through the conveyor system.

Conveyor weighers are for weighing coal passing over a belt, a bucket or some other type of conveyor, while the coal is moving along on the conveyor. There are several of these machines on the market, and some of them are guaranteed within 1 per cent. of accuracy. They are automatic in their operation.

In modern boiler rooms it is customary to store a certain amount of coal in overhead bins, usually about two to four days' supply. These bins are rather expensive, so that cheaper storage for a larger reserve supply is usually provided elsewhere around the plant. This reserve storage is really an insurance against running out of coal, and the amount of storage space depends largely on local conditions and upon the judgment of the management as to the investment justified. As a rule some means is provided for mechanically transferring the coal from the reserve storage to the active storage, the amount of expense justified for this equipment being determined by the quantity of coal which it is likely to be called upon to transfer each year and therefore by the saving possible in the cost of transferring this coal. This depends largely on the regularity of the supply, since if coal is received every day, it may be necessary to call on the reserve storage only at long intervals.

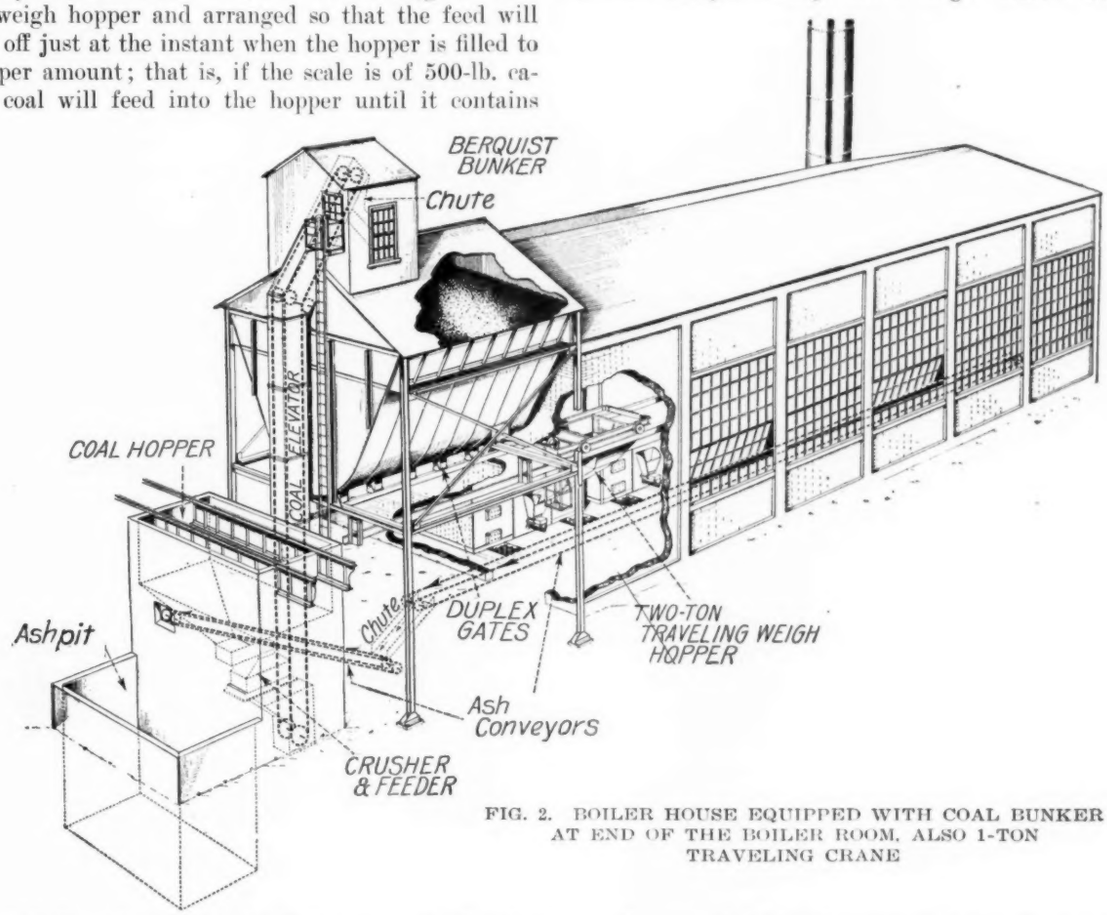


FIG. 2. BOILER HOUSE EQUIPPED WITH COAL BUNKER AT END OF THE BOILER ROOM, ALSO 1-TON TRAVELING CRANE

In a plant arranged as described, the weighing equipment is usually located between the active storage—that

is, the overhead bin—and the stoker magazines, so that the coal can be drawn from the overhead bin and weighed before it is delivered to the stokers (Fig. 1). The type of equipment used is the traveling weighing hopper or the individual automatic scale. As a rule the overhead bin is

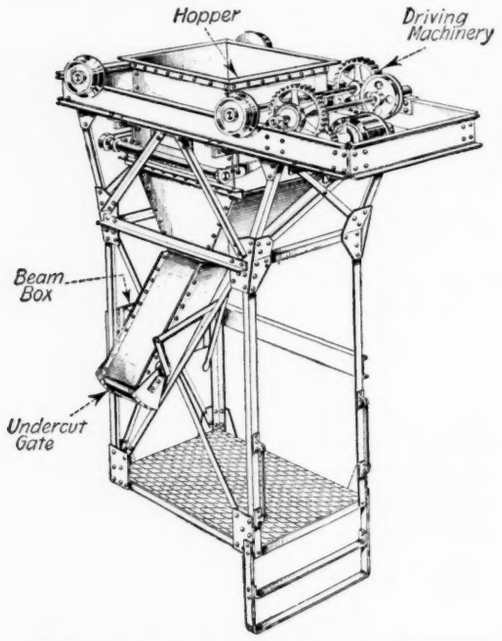


FIG. 3. ONE-TON TRAVELING WEIGHING HOPPER WITH OPERATOR'S CAGE

situated in front of the boilers and the weighing hopper runs on tracks below the bin and supported from it or from some of the steelwork. The balance beam of the scale is placed at a point near enough to the boiler-room floor for the operator to reach, and it is usually equipped with a ticket-punching device for recording the weights. Sometimes a platform or cage is provided on which the operator rides (Fig. 3).

Where the service is light, the weighing hopper is sometimes moved along the tracks by means of a shaft geared to one of the axles and operated by a chain wheel and a hand chain which extends to within easy reach from the boiler-room floor (Fig. 4). The hand-operated machines are, however, fast going out of use, and the weighing hopper is being equipped with a motor geared to one of the axles. The motor is controlled by means of a controller with two ropes hanging within reaching distance of the floor. Pulling one rope causes the machine to travel in one direction, and pulling the other one causes it to travel in the reverse direction.

There are two ways of equipping a traveling weighing hopper with an automatic scale, instead of using a hand-operated scale. One is to place the automatic scale above and the receiving hopper below, so that the coal is weighed as it is drawn out of the overhead bins and before it is delivered to the receiving hopper. The machine is then placed opposite a stoker hopper, and the coal is delivered to it. This is the best arrangement where the only record desired is the total amount of coal consumed by the several units. The other way is to place the receiving hopper above and the scale below, so that the coal can be drawn from the overhead bin into the receiving hopper and then weighed by the automatic scale just as it is delivered to the stoker hopper. With this arrangement a certain weighed amount would be delivered each time to a stoker hopper, and there must necessarily be room in it for such an amount, or the coal will overflow and spill on the floor.

One disadvantage in the use of automatic scales on a traveling weighing hopper is that it takes more of the operator's time, since the scale must not be operated too fast or it loses in accuracy. Where the scale is placed below the receiving hopper, the operator must be careful not to overload the stoker magazines and spill the coal on the floor. Another objection to the automatic scale on these movable hoppers is the height required underneath the bins, since the scale itself takes up considerable height, in addition to that required for the receiving hopper and spouts to the stokers. Where the bin is in the boiler room, this additional height means not only raising the bin and lengthening the supports for it, but also making this part of the building higher in order to accommodate this bin.

Two advantages that can be claimed for traveling weighing hoppers are that the gates in the bottom of the bin can be placed close together so as to better drain out the coal, and the overhead bin can be located either in front of the boilers or at some other convenient point, say at the end of the building or just outside the end of the building (Fig. 2). This avoids the necessity of making the building so high in front of the boilers to accommodate the bin and also makes it possible to use almost any shape or depth of bin that is most economical

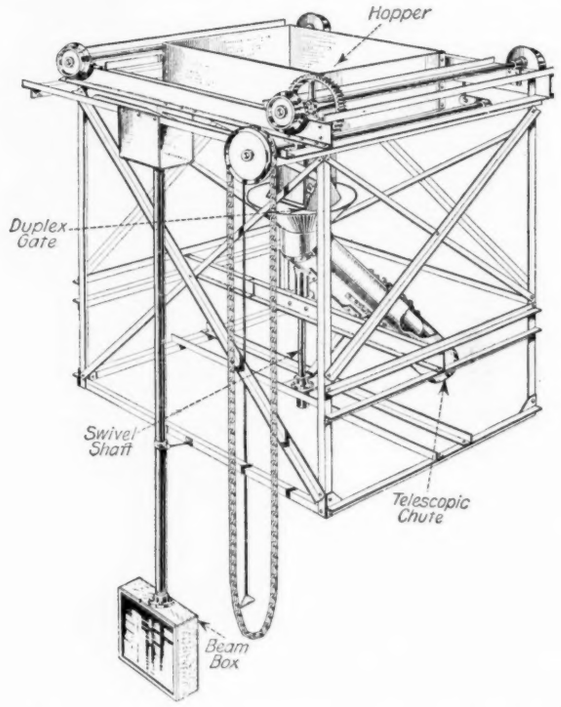


FIG. 4. WEIGHING HOPPER, HAND OPERATED

and fits in best, instead of a long bin of comparatively small cross-section, as is necessary when it is located in front of the boilers. The placing of the bin in front of the boilers, however, has the advantage of reducing the length of travel for the weighing hopper to a minimum. It also makes a compact arrangement, using the least amount of ground space and as a rule giving the best appearance, since a bin at one end is apt to destroy the architectural symmetry of the design.

As previously stated, the individual automatic scale for each unit is the ideal way of obtaining the amount of coal consumed by each unit. A 100-lb. automatic scale is not a very costly device, and it will handle up to 4 tons per hour, so that it does not make a very expensive installation to have one of these scales for each boiler, where the boilers are quite large. These scales require no attendance, whereas the traveling weighing hopper has to be filled, moved along and discharged by the operator, and in larger boiler rooms this frequently means an additional man over the number required with the individual automatic scales.

Where there are several of these scales, they can be driven from a lineshaft operated by a single motor, instead of having a separate motor for each one. The power required is very small. In order to allow for the cleaning and removal of the boiler tubes, the scales must either be placed high enough so that the tubes will clear them, or they must be supported on rollers running on overhead tracks in a somewhat similar way to the regular traveling weighing hopper, but to be used only in case it is necessary to push the scale to one side to get at the tubes. The coal feeds down through the scales and the spouts to the stoker magazines, and as the stoker uses up the coal in the magazine, more feeds down the spout until the weighing hopper is entirely discharged, when the operating mechanism is again thrown into operation by the closing of the lower gate and the scale goes through another operation of filling up, weighing and discharging.

The type of weighing device that will best fit into one place will not always be applicable to another, so that it is a case of deciding from experience and from local conditions; and in designing a new power plant it is important to decide as early as possible what equipment will be used, so that the proper provision for this equipment can be made in designing the building and the overhead bin arrangement.

The Installation of Motors—II

By R. Thistlewhite

SYNOPSIS—The proper size of fuses to use and their correct location to protect a direct-current or an alternating-current circuit is discussed. The limitation of the fuse as a protective device for electric circuits and where to use circuit-breakers are also considered.

Fuses are made and allowed in two forms—open type, or link type, and inclosed type. The latter is divided into two classes—the Edison plug type and the cartridge type.

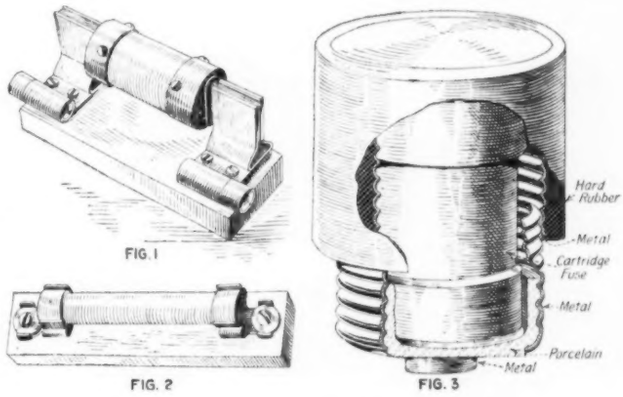
Link fuses can be obtained for any amperage, but are restricted in use somewhat by being allowed only when installed on marble or slate bases such as panelboards or switchboards, and will always have to be inclosed in a cabinet except when used on main switchboards. The fuse must be made with a terminal of harder metal than the fuse material and be stamped for about 80 per cent. of the maximum continuous carrying capacity.

There are two sizes of Edison plug fuse—one made from 0 to 30 amp. for 125-volt circuits and also allowed on a 125-250-volt Edison three-wire system having the neutral grounded; and the other, the same style but somewhat larger in diameter, from 30-60 amp., and used in a cutout base which is made a little larger than the standard.

The cartridge fuse is much more reliable than the plug fuse and can be used on 125- to 600-volt circuits for amperages up to 600, as will be seen from the following table:

Voltage	Amp.	Length Over All, In.	Distance Between Contact Clips, In.	Kind of Contact Clips
Not over 250	0–30	2	1	Ferrule contact
	31–60	3	1.75	Ferrule contact
	61–100	5½	4	Knife-blade contact
	101–200	7½	4.5	Knife-blade contact
	201–400	8½	5	Knife-blade contact
	401–600	10½	6	Knife-blade contact
Not over 600	0–30	5	4	Ferrule contact
	31–60	5½	4.25	Ferrule contact
	61–100	7½	6	Knife-blade contact
	101–200	9½	7	Knife-blade contact
	201–400	11½	8	Knife-blade contact

Above the values of 400 and 600 amp. on power lines, circuit-breakers must be used; but if used for lighting circuits, fuses may be put in parallel, provided that the smallest number of fuses are used to make up the total amount of current to be carried. The knife-contact clip type is shown in Fig. 1 and the ferrule-contact type in Fig. 2. The cartridge fuse can also be used in the Edison plug cutout base if used in conjunction with the plug-fuse casing shown in Fig. 3.



FIGS. 1 TO 3. TYPES OF INCLOSED FUSES

Both these types of fuses—that is, the plug and the cartridge—can be refilled and will be passed on any installation if the refilling is done by the manufacturer of the fuse. The makes that are arranged for the man on the job to refill, either with a specially made metal, or with fuse strip, will be passed only under certain conditions, and before being installed the inspector should be applied to. The refillable fuse is being watched at the present time, to gather data on its action under ac-

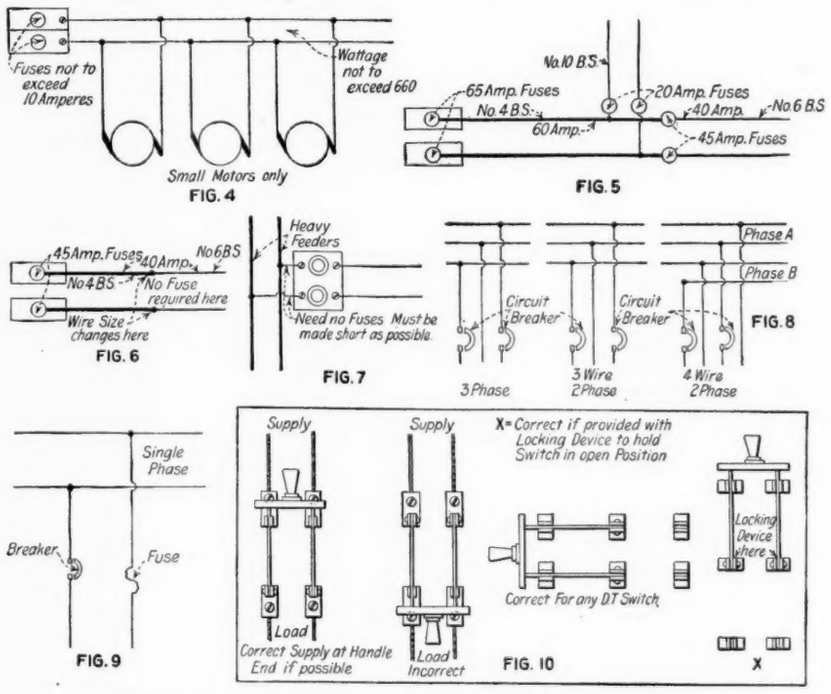
tual conditions usually called for in practice, with the view of allowing this fuse to be used under all conditions. No decision has been rendered up to the writing of this article.

Each conductor leading to a motor must be protected by a suitable size of fuse and controlled by a switch to open all wires at one time, the switch being placed as close to the motor as possible, so that the operator will be within sight of the motor when starting. Small motors may, however, be arranged in groups, as in Fig. 4, and protected by one set of fuses. The total watts of the motors so arranged shall not exceed 660, the fuses not to be larger than 10-amp. and the voltages not over 300. The main switch previously mentioned may be omitted when the motor is started by means of an automatic starter that will open all wires when it is operated to shut down the machine. This does not mean that the overload device, with which starters are sometimes equipped, will take the place of this switch, because this attachment does not usually open all wires leading to the motor. Fuse protection is wanted not only at the motor, but also for the wires feeding it; for instance, if the wires change size as they run from the supply to the load. In Fig. 5 fuses will have to be placed at the point where the changes are made, but if as shown in Fig. 6, the fuse at the supply will protect the smaller wire in the run, and the fuse in the latter can be omitted. Conditions can be found where it would be convenient to connect a small wire to a very large feeder. This can be done as shown in Fig. 7, the wires between the cutout and the feeders being made as large as convenient and as short as possible. All fuses must either be in plain sight or inclosed in proper cabinets, or cutout boxes, made of metal if the wires are run in conduit, armored cable or metal molding.

The purpose of this fuse protection is, first, to protect the line wires against overheating and, second, to protect the apparatus these wires are supplying with current. If this is kept in mind, there will be no difficulty experienced in selecting the correct size of fuse for any purpose. The carrying capacities given in the wire table for rubber-covered wire are lower than those given for other insulations in order to keep the temperature of this wire low and also because the covering is relied on for insulation. Wires having no rubber in their coverings, known as weatherproof, slow burning, and slow burning weatherproof, are treated in all respects as bare wires and must be run open, mounted on glass or porcelain knobs.

In all cases except for alternating-current motors, the fuses for a given wire must not exceed the carrying capacities given in the wire table. For instance, suppose that a direct-current motor which requires 90 amp. is connected through No. 0 B. S. rubber-covered wires; the correct size of fuse would be at least 90 amp., but not greater than 125 amp., this being the maximum carrying capacity of a No. 0 wire.

For alternating-current motors a little leeway is allowed because these motors take a much larger current to start them than direct-current machines. For example, suppose the motor referred to in the preceding paragraph was of the induction type; then the maximum size of fuse could be increased up to the capacity of a No. 0 B. S. for other insulations, or 200 amp. This would mean that the No. 0 wire would actually be overfused during the period of starting, which would be only for a very short time and is allowed. If the fuses are not large enough to start the motor, the next larger wire



FIGS. 4 TO 10. INDICATE THE PROPER PROTECTION OF ELECTRIC CIRCUITS

would have to be used; that would be a No. 00 wire, which could be fused up to 225 amp.

Standard squirrel-cage type alternating-current motors when started with a compensator or auto-transformer, will usually take about the following percentage of their full-load current rating:

Rated Full-Load Current	Percentage
0-30 amp	250
31-100 amp	200
Above 100 amp	150

Example: A 250-volt induction motor has a full-load current rating of 50 amp. About what will be its starting current?

Percentage taken from table is 200, and 200 per cent. of 50 is equal to 50 × 200 divided by 100, or 100 amp. starting current. A No. 3 B. S. wire could be used for this motor.

There are a great many types of circuit-breakers operating under different circuit conditions. Circuit-breakers can be obtained having one, two, three or four poles, which may be opened or closed, all at one time or separately, either automatically or by hand; or they may be arranged so that they cannot be operated separately by hand, which is usually the case on power circuits.

These combinations can be equipped with a device which will not open the circuit at the instant that trouble occurs, but will hold for a predetermined time, after which the breaker will open. This device is desirable

on circuits containing alternating-current motors, as it allows sufficient time to elapse for the starting current to reduce down to normal. This time element is also obtained with a certain type of fuse which, on account of first cost, may make it more desirable than a breaker in most cases.

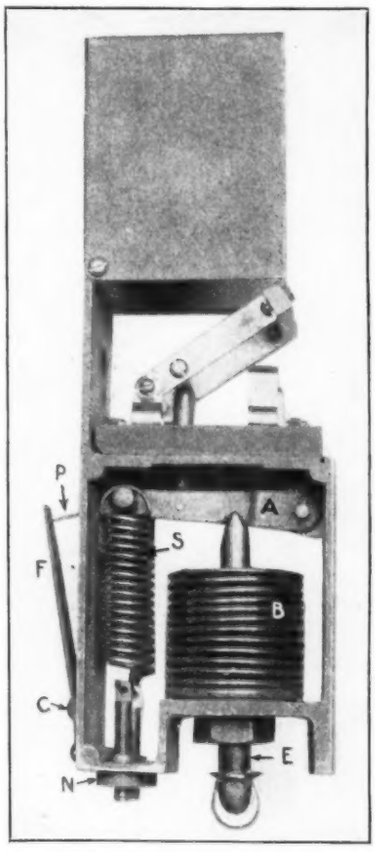
For protection of motors where fuses are not used, the breakers will have to be mounted on the main switchboard or otherwise be under expert supervision. They will have to operate when an overload occurs and be arranged so that they will open all wires at once; the time-limit device can be used or not, to suit the conditions of the particular job. In protecting circuits by circuit-breakers, one breaker must be placed in each leg of a two-wire system and the two outside legs of a three-wire system, in each of the two phases of a two-phase and in any two phases of a three-phase three-wire system, as in Fig. 8, and in each phase of a three-phase four-wire system. Single-phase circuits need only one breaker if a fuse is placed in the other leg of the circuit, as in Fig. 9.

Breakers without time-limit devices or fused cutouts must never be set at a higher value than 130 per cent. of the current-carrying capacity of the wires. When protecting alternating-current motors, they can be set to as high as 125 per cent. greater than the full-load current of the motors they are protecting, providing they will not operate during the starting period of the motors.

Circuit-breakers and switches must always be placed so that gravity will tend to open them. Where double-throw switches are installed vertically, a locking device must be provided on the hinge of the switch so as to hold the blades open. Fig. 10 shows correct and incorrect installation of switches. If it is possible, the switch should be connected so that the blades will be dead when the switch is open, thus leaving as little exposed copper as possible.

The Sylphon Pressure Regulator

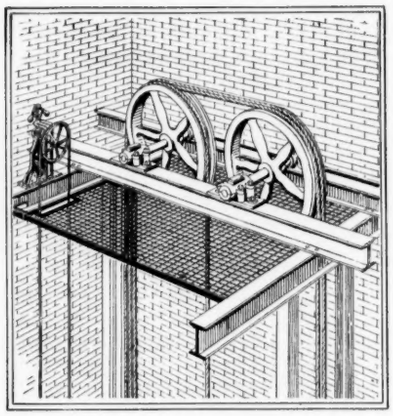
With the ever-increasing use of electric motors the tendency is toward automatic control. This control may be obtained by closing a knife-switch by hand when it is desired to start the motor and opening it again to stop the machine. But in many cases the conditions of the work determine the starting and stopping of the motor. For example, where a motor is used to drive a pump to maintain a pressure in an air or water system, the requirements are that the motor will start the pump when the pressure decreases to a predetermined value and stop the pump when the pressure has increased to a certain amount. The pressure switch shown in the figure is designed to operate over a wide range of pressures. It is known as the Sylphon pressure regulator and is manufactured by the Automatic Switch Co., New York. This switch provides a simple nonmagnetic means for opening and closing motor circuits, either direct, in case of small motors, or through the medium of a magnetic switch, on large machines, by predetermined variations in pressure. Instead of using a diaphragm, as is the case in many pressure regulators, what is known as a Sylphon metallic bellows is employed. The bellows is shown at *B* and consists of a piece of brass tube spun to form a bellows; a stem is fastened to the top of the bellows and extends up, engaging an arm *A* from which a rod extends and connects to a standard 30-amp. 250-volt double-pole knife-switch, as indicated. Connection between the bellows and the pressure system is made through a standard ¼-in. pipe, shown at *E*. The arm *A* acts against two spiral springs *S*, which provide a wide change in starting or stopping points by adjusting the nuts *N*. Adjusting the tension of the flat compensating spring *F* by the screw *C* permits a wide change in the variation between the starting and stopping point and in this respect differs from all similar devices. When the switch is in the open position shown in the figure, the pawl *P* is at an angle that will cause the compensating spring to tend to hold the switch open. Consequently, for the spiral springs *S* to close the switch the pressure will have to decrease to a value where they can overcome this pressure and also the upward push of spring *F* against the pawl. However, when the switch does start to close and the end of the pawl engaging the end of arm *A* drops below the horizontal, the flat spring will assist the spiral spring to close the switch, causing a quick make. The same effect is obtained in opening the switch, which causes it to open quickly and prevents burning the contact. The switch is built for pressures ranging from 18 to 38 lb. per sq.in., to 170 to 225 lb. per sq.in.



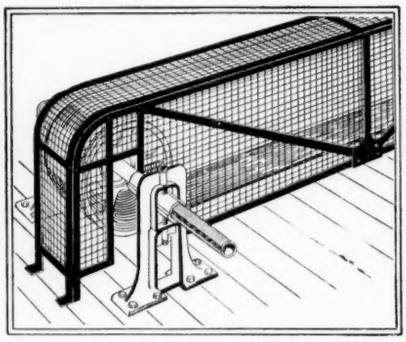
SYLPHON PRESSURE REGULATING SWITCH

Power Plant Operated from a Volcano—According to the "Electrical World" a power plant containing three 3,000-kw. turbine-driven units that utilize the heat of volcanic steam has been put in operation at Larderello, in central Tuscany, Italy. In this district there are numerous cracks in the earth that permit jets of superheated steam to escape to the air. It was found unsatisfactory to utilize this natural steam directly in the prime movers on account of the borax salts and the gases mixed with the steam. In the present installation holes have been bored to the source of the steam, which is from 300 to 500 ft. below the surface of the earth. The pressure of the volcanic steam thus obtained is from 30 to 75 lb. per sq.in. at a temperature of from 150 to 190 deg. C., and is utilized by applying it instead of fuel to a specially constructed multitubular boiler. Steam is generated at about 22 lb. per sq.in., is superheated and then passes through the turbines into a surface condenser. The condensate from the turbines is pumped back into the boiler, and thus no natural steam comes in contact with the turbine. The generators are three-phase 6,500-volt 50-cycle machines. The first one was put in operation in January, 1916, the second in April and the third recently. So far the first two machines have worked quite successfully. This harnessing of volcanic heat to electric power houses can be increased to the extent of hundreds of thousands of horsepower, since volcanic steam can be secured from an area of many square miles around Larderello.

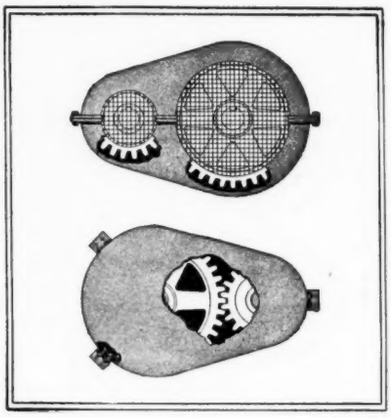
Some Practical Safety Guards*



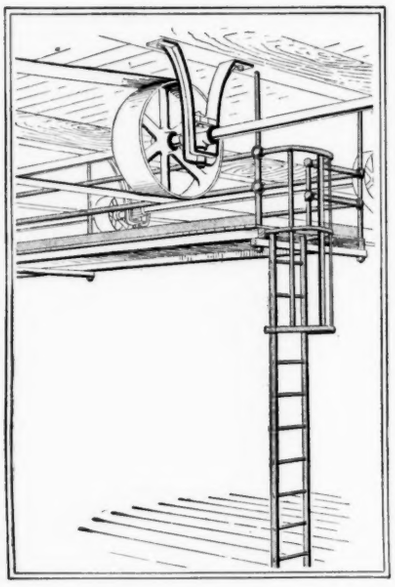
NETTING FOR ELEVATOR SHAFT



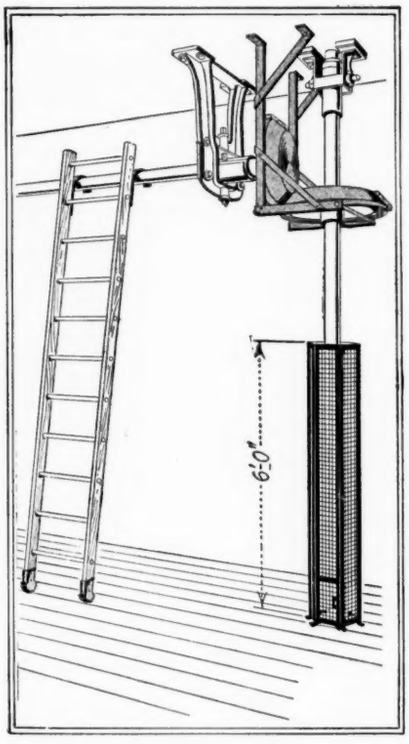
GUARD FOR BELT AND SHAFT



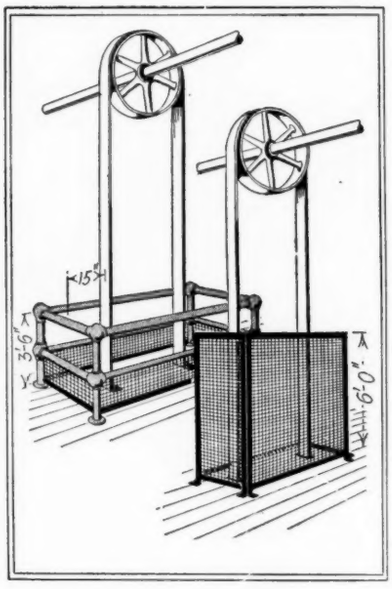
GUARD FOR SPUR GEARING



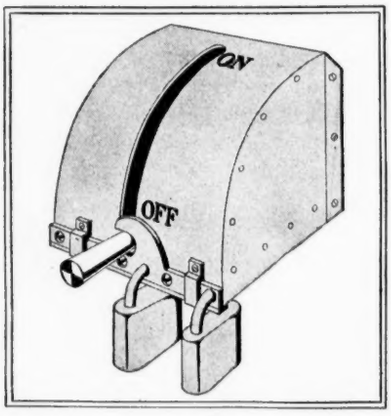
A BELT AND PULLEY GUARD



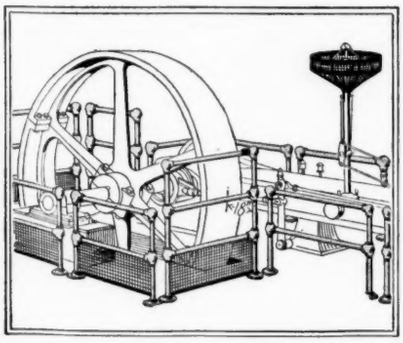
OILING LADDER, SHAFT AND GEAR GUARD



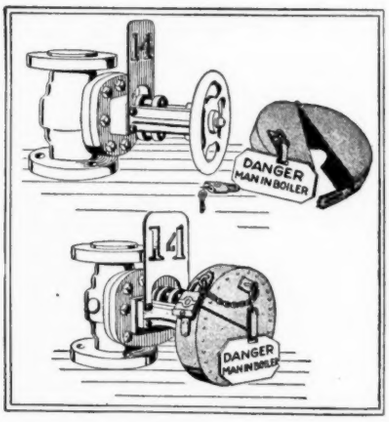
A GUARD FOR VERTICAL BELTING



TWO PADLOCKS FOR ELECTRIC SWITCH



ENGINE RAILING AND WIRE GUARDS



A VALVE LOCK FOR PIPE LINES

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Steam-Engine Troubles—Frames

By H. Hamkens

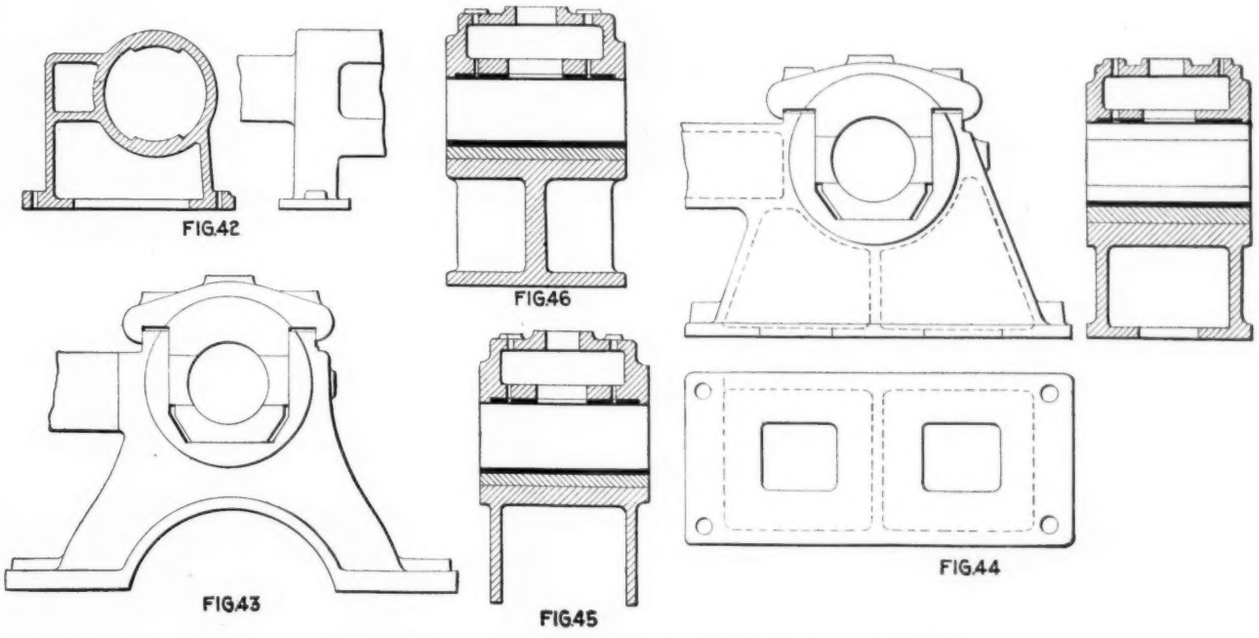
SYNOPSIS—The advantages of bored guides are pointed out. Various forms of engine frames and the service to which they are adapted are discussed. All engine frames should be provided with oil channels to prevent oil soaking into and disintegrating the foundations.

Bored guides are the standard. Fig. 38 shows this type. The trouble with the V and the flat guides, shown in Figs.

FIGS. 38 TO 41. VARIOUS TYPES OF ENGINE GUIDES

39 and 40 respectively, is that it is almost impossible to get them in line with the bore of the cylinder, which is essential in a well-running engine. The only rational way to attain this is to run a boring bar through and do the facing of the end for the cylinder head and the boring of the guides at the same setting; this will insure perfect alignment, a thing which cannot be accomplished with the other kind of guides.

An advantage of the bored guides is that the crosshead can accommodate itself to the connecting-rod and crank-pin. If for some reason the crankshaft should get out of line, perhaps through unequal wear of the main and outer bearings or a settling of the foundation, the bored guides will permit the crosshead to roll sideways without throwing any extra strain on the pins or the connecting-rod, while the V or the flat guides will make the crosshead shoes bind on the sides and run hot. Another good feature is that with bored guides the lubrication seems to be more effective than with the other two styles. The oil has a tendency to spread evenly over the lower guide when struck by the cylindrically shaped crosshead shoe. On the V guides it will run toward the center groove where the crosshead shoe cannot touch it, and on the flat guides it will spread over one side only and leave the other dry unless the guide is level. Very few crossheads used for the V or the flat guides can be removed without taking off at least one of the shoes; frequently both of them have to come off, and the engineer has his hands full when he undertakes to do the job. With the old-style shoes that lap over both ends of the crosshead and have a wedge for adjustment inside, it is even necessary to remove the connecting-rod. All this trouble is avoided with the bored guides, where the crosshead can be rolled around and taken out through the opening in the side. A very antiquated style is shown in Fig. 41. The bearing surface is milled in halfmoon shape to a small radius. These are even worse than the V-shaped or the flat style, since it is almost impossible to make any correction by filing or scraping if they are not parallel and central.



FIGS. 42 TO 46. ENGINE GUIDES AND PILLOW BLOCKS

Fig. 42—Upper and lower guides rigidly connected. Fig. 43—Improper pillow block design. Fig. 44—Good pillow block design. Fig. 45—Insufficient support of pillow block at base line. Fig. 46—The rib sections shown are weaker than box section

The object of the frame of an engine is evidently to counteract the forces transmitted from the cylinder through the piston, piston rod, crosshead, connecting-rod and crank to the shaft and main bearing, and also to prevent the engine from moving on the foundation. With this in view we can readily see that the girder frame should be used only for light work. The tendency is to overload an engine, either from a mistaken standpoint of steam

economy or from a desire to increase the output without going to the expense of adding to the equipment. To do this on a girder frame is a rather hazardous undertaking and may result in disaster, unless the frame is built on certain approved lines. As explained previously, the

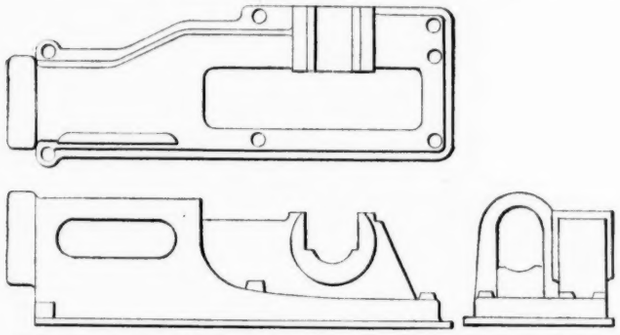


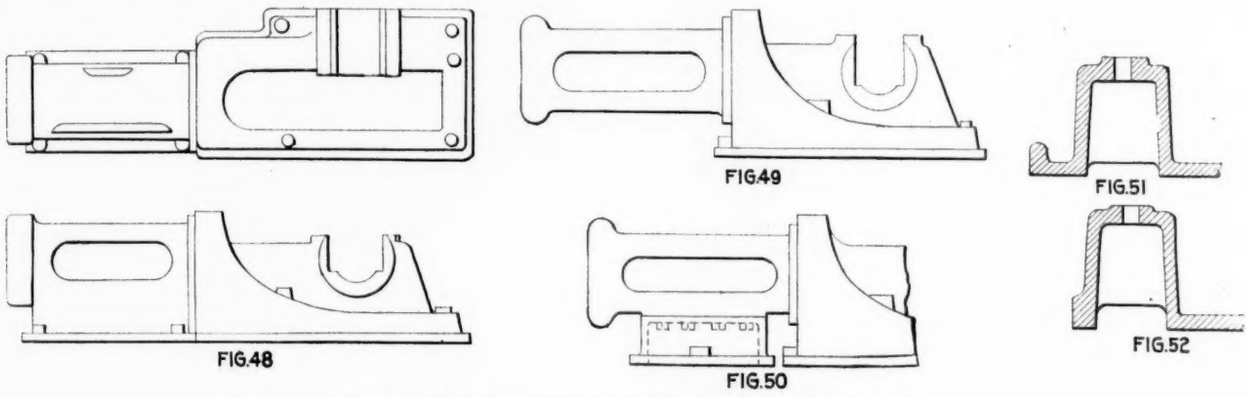
FIG. 47. ONE-CASTING HEAVY-DUTY ENGINE FRAME

girder frame should have bored guides, and it would be well if the girder part could be of box section instead of the conventional I-beam section. The slide pedestal should be cast onto the frame, not bolted on, and the upper and lower guides should be rigidly connected, as shown in Fig. 42. If the end of the guide barrel has no support on the foundation, as, for instance, in the original girder frames made by George H. Corliss, there is quite a noticeable deflection every time the crank turns over its upper or lower center. Of course the bolting on of a support is only a convenience for engine builders, to make the frames do for right- or left-hand engines. Another convenience which manufacturers introduced years ago, and which is still a source of trouble to the engineer, is the bolted-on main pillow block. Bolts will stretch and nuts will get loose in spite of all precautions, which, of course, cannot happen in this particular instance if the frame and main-pillow block are cast together.

The design of a pillow block needs some serious attention. If made as shown in Fig. 43, there will be a certain amount of deflection in the center, which may result in fracture. Some of the most valuable metal has been cut away, supposedly under the impression that a graceful arch would best answer the purpose of sustaining the weight of the shaft, flywheel and crank. An architectural design rarely meets the requirements of engine practice, where the forces constantly change in magnitude as well as in direction. A dead load is altogether different from the strain caused by a revolving flywheel and the reciprocating parts of an engine, with all the attendant forces due to the pressure on the piston. Beautiful lines and curves are of little value to the engineer—strength and rigidity are what he expects of an engine frame. The late Professor Sweet's "straight line," backed by a lot of solid metal, is vastly superior to elegant curves and fanciful shapes on engine work.

Fig. 44 shows a good design of main pillow block. The base has full bearing on the foundation, and the shaft is supported in the most natural and direct way. There are just sufficient openings in the base for removing the cores, otherwise it is one continuous surface. This is a substantial construction, and if designed in the proper proportions it will give satisfaction. There is no attempt made to save expense by sacrificing strength, as in the pillow blocks shown in cross-section in Figs. 45 and 46.

Fig. 45 illustrates a case of insufficient support at the base line and is contrary to all sound principles. There are no return flanges provided, consequently it is impossible to use grouting on this construction. The object of this design is to save a few dollars by letting the inside of the pattern leave its own core. Fig. 46 is another design from which trouble may be expected. It is made of rib section with the idea of saving core work, the base is broad and long, but rib sections do not compare in strength with box sections; they seem to have a natural tendency to develop cracks, probably owing to shrinkage strains.



FIGS. 48 TO 52. FORMS OF STEAM ENGINE FRAMES

Fig. 48—The two-piece frame has not the advantages of the one-casting frame. Fig. 49—The inadequately supported guides are unsuited to heavy work. Fig. 50—This is but little improvement over Fig. 49. Fig. 52—Section of frame; notice broad flange forming oil channel. Fig. 52—The narrow reinforcing strip gives a poorer bearing on the foundation than the broad flange in Fig. 51

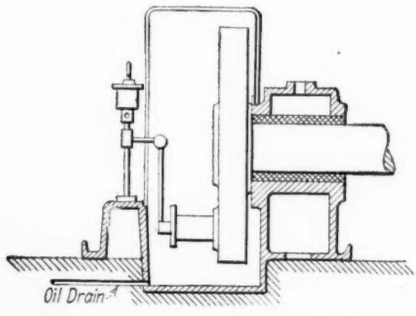


FIG. 53. CRANKPIN SECTION

For heavy, continuous service an engine should be pravided with a so-called heavy-duty frame as shown in Fig. 47, which is made in one casting with a wide continuous bearing on the foundation. Guide barrel and main pedestal are in one piece. In this one-piece design it

is possible to counteract all strains in the most direct way and there are no sharp breaks in the lines, or offsets with sharp corners where cracks could develop. The argument that a frame of this kind is subject to dangerous shrinkage strains cannot be maintained, for the casting can contract freely in the mold in all directions. Another advantage is that it requires little machining and fitting and is easy to line up in erecting if it is once fitted right in the shop, which is not always the case with the two-piece frame shown in Fig. 48. On the latter design the frame and guide castings are machined separately and bolted together. In shipping, the two pieces are taken apart again and the chances are that there is more or less trouble in lining up when the engine is erected, as many an erecting engineer has found out to his sorrow. The joint between the two pieces is the weak spot; tap-bolts are mostly used to hold the two parts together and on some designs, even links are shrunk in, which is, of course, open to severe criticism.

Guides that are not supported on the foundation, as shown in Fig. 49, are not fit for heavy work. There is always a certain amount of deflection in them, and often the lower crosshead shoes give trouble on account of this—a puzzle to the engineer, who wonders what can be the matter with the crosshead that makes the lower shoe and guide run hot, and why they require such a lot of oil. Even if a foot is bolted on under the guide, as shown in Fig. 50, the design is only an excuse for a heavy-duty

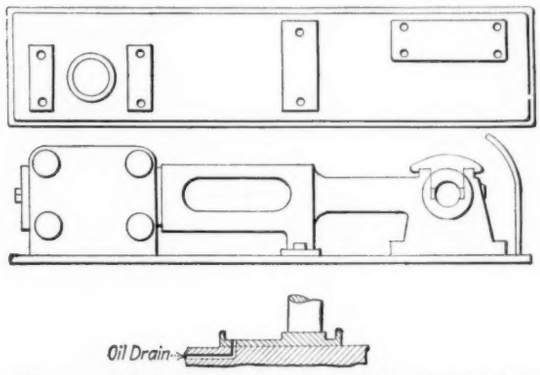


FIG. 54. CAST-IRON SOLE-PLATE UNDER FRAME

frame and does not compare in strength and rigidity with the one shown in Fig. 47. For extremely heavy work the bottom of the frame should be a continuous plate with enough openings for removing the cores, but for less strenuous work it will be sufficient if a broad flange is run around the outside, with a rib turned up to form an oil channel, as in Fig. 51. This is far superior to the method shown in Fig. 52, where the edge at the bottom is reinforced by a narrow strip, which does not afford a good bearing on the foundation and will not keep oil from running on the floor if any gets on the frame. An oil channel all around the frame is one of the things that a modern engine should be provided with. If it is not, some oil is bound to get on the floor and, worse, on the foundation, where it will destroy the grouting and weaken the concrete.

Oil used for lubrication should be free from grit and dirt; therefore it is best to filter all of it, even the new supply. Filtered oil is often better than the original article, since the volatile parts have been eliminated in the filtering process. One of the advantages of the heavy-duty frame is that it has a bottom cast in the crank pit and oil used on the guides, crosshead, crankpins and main bearing can be made to drain into this pit and from there to a tank, or direct to a filter. Fig. 53 shows a cross-section through the crank pit at the main bearing. With the girder frame matters are different. It is open on all sides and has no provision for catching oil. The common practice is to collect in tin pans the oil that is thrown off. It is almost impossible to keep an engine room clean

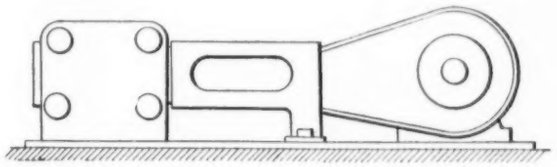


FIG. 55. OIL GUARD FOR HIGH-SPEED ENGINES

with these contrivances, which will begin to leak in a short time or are likely to be upset, making the floor slippery and nasty. A much better way is to provide a continuous cast-iron sole plate under the whole girder frame, as shown in Fig. 54. The plate may be made in one piece or in two bolted together, according to the size of the engine, with a separate plate for the outer bearing. The outer edge of the plate should have a bead running all around it, and if there are any holes, as for instance under the cylinder for the exhaust pipe, they should also have beads around them to prevent oil from running through. The plate should slope from all sides toward the crank or some other convenient point, and the oil should be drained off. A simple oil shield for the crank, as in Fig. 51, is generally sufficient for a slow-running engine, but if the speed is over 100 r.p.m. or the piston speed over 600 ft. per min., the connecting-rod and crank should be inclosed by an oil guard, as in Fig. 55. The combination of the continuous sole-plate and this kind of oil guard can be recommended; it will pay for itself in a short time.

[*The next article treats of the lubrication of crankpins and bearings. Foundations are discussed, too.*]

Special Records of Equipment

By H. S. Knowlton

The importance of maintaining a complete and accurate record of equipment tried out and rejected may well be emphasized in view of possible complication in subsequent adjustments between the plant owner and the manufacturer, and in this the operating engineer can be of great assistance to his employer. No matter how good one's memory may be, it is not like quoting from logsheet entries.

A case of this kind was handled in a satisfactory manner in connection with a large turbine plant. It was agreed that the turbine maker might install his particular oiling system and endeavor to make it work satisfactorily but it was rejected after a period of 21 months, during which time a complete record was kept showing every detail of work done upon the unaccepted unit from the first to the end of the experimental period, and the cost was charged to the manufacturer.

The extra fuel cost alone amounted to about $30,000, and settlement was made on the basis of the date of the operating engineers. It would be hard to find a better instance of the value of a thoroughly compiled "unit log," and even in small plants it pays to keep a pretty complete history of the individual units.

Steam Engineer's License Examination—II

By H. F. Gauss

SYNOPSIS—This article deals with furnace design, safety valves, fusible plugs, water columns, priming, cutting-in a boiler and boiler feeding, giving special attention, in the subject last named, to injectors.

In the course of the discussion on boilers the design of furnaces was brought out and emphasized. At present a very important quality in a successful engineer is the ability to design and operate his boiler furnaces without violating laws relating to the smoke nuisance. With anthracite this is not difficult, but with bituminous coals such as are used in the Middle West, the result can be obtained only by careful attention to the fundamental principles of combustion. In small plants containing tubular boilers and in plants of moderate size, say of 500 hp. or less, that do not have to be forced excessively, the down-draft furnace construction gives satisfactory results in all respects. A recent test on a 410-hp. water-tube boiler fitted with a down-draft furnace showed a combined boiler and furnace efficiency of 72 per cent. with a smoke production well within the city requirements.

Properly constructed mixing arches in the combustion chambers of hand-fired boilers aid materially in preventing the formation of smoke. These arches are built behind the bridge-wall and at such a distance from it that the horizontal area between the bridge-wall and the arch is from 40 to 50 per cent. of the grate area, while the vertical area through the arches should be about 45 per cent. of the grate area. Some authorities give the latter as 50 per cent.

The theory is that the hot gases, by being compelled to pass underneath the arches, are thoroughly mixed with the air and hence burn completely without the formation of smoke. Steam jets above the firedoors are effective in drawing in and mixing a supply of air, especially at times of firing. An objection to their use is the loud noise they make, and some fear that the action of the steam with the probable sulphur in the products of combustion is injurious to the metal parts of the setting.

For larger steam plants where the boilers have to be forced continually, a successful solution of the smoke problem with coals of the Middle West is the chain-grate stoker. In any case, however, the prime requisite for complete and smokeless combustion is an adequate supply of air, preferably preheated, brought into intimate contact with the burning fuel and intimately mixed with the liberated gases in the hottest part of the furnace. The flames should not be allowed to come into contact with the cold surface of the tubes or shell before complete combustion has been insured. This last result is secured by providing an arch of fire-tile over the furnace and combustion chamber, it being sometimes permissible to expose the tubes or shell over the front part of the grate without cooling the gases sufficiently to interfere with their perfect combustion. A moment's thought will show that these conditions can be obtained readily with a chain-grate stoker. As the traveling grate carries the fuel into the furnace, it is first coked. The volatile gases being gradually and uniformly driven off, pass over the hot incandescent fuel bed on the rear of the stoker, and beneath the hot arch, where they are completely burned without the formation of smoke.

Points to be watched in regard to safety valves are their capacity, their location and their connection to the boiler. They should be of sufficient capacity to freely discharge all the steam a boiler can be forced to generate as fast as it can be generated. This means that should a plant, running under full load, suddenly be shut down and no steam taken from the boilers, the safety valves would be able to relieve the boilers, permitting a rise of not more than 6 or 8 lb. pressure[1]. Of course, in such an event the firemen should close the dampers, open the bleeders and speed the feed pump a little if possible.

In regard to closing the dampers, it may be stated here that a choked draft often results in a burned-out furnace lining, and the dampers should be handled only by a man well posted in the action of the particular furnaces under reduced draft.

The safety valve should be in such a location that the connection to the steam space in the boiler is short and direct. Under no conditions should a stop valve or obstruction of any kind be placed between the safety valve and the boiler. The ordinary rules for designing lever and spring-loaded safety valves are familiar to all or are easily obtainable and will not be repeated here.

Fusible plugs should be inserted where the hot gases are in contact with their outside surface, and should be at least an inch above any tube or metal that might be injured by becoming dry.

Horizontal return-tubular boilers may have one or more fusible plugs inserted in the rear head 2 in. above the top row of tubes. The fact that the water line in the drums of water-tube boilers is seldom level, owing to the rapid rise of water through the front leg and its rapid flow through the drum to the rear leg, makes the exact location of fusible plugs in these boilers difficult[2]. Instances have been known where it was necessary to lower the plugs in water-tube boilers because the roll in the water due to rapid circulation exposed them, and to carry the water in the glass higher would have caused priming. A common location for the fusible plug in water-tube boilers is in the front sheet of each drum, about 1 ft. from the forward girth seam, and 4 in. below the normal water level, the normal water level being a horizontal line passing through the center of the drum at its middle point.

The water column should be so placed that the lowest point on it at which it is possible to see the water is level with the fusible plugs. The reason for this is that, with a fusible plug below the lowest possible level indicated by the water column, the engineer has always the temptation to take a chance on opening up the feed-water valve, should he suddenly find the water gone from sight in the glass, arguing that since the fusible plug has not yet blown, the water must still be above the fire line. The fusible plug is not reliable enough to depend on in such

[1]The A. S. M. E. Code gives the allowable pressure rise under these conditions as 6 per cent. of the pressure at which the valve relieves.

[2]The water-tube boilers here referred to are the horizontal-drum type similar to the O'Brien, Heine, B. & W. or Erie.

an emergency, and it is well to remove this temptation from the engineer and fireman.

The fact that a light scale deposited over the inner surface of the plug effectively seals it up, and also the age of the metal in the plug affects its melting point, renders the plug an unreliable indicator of the water level in the boiler.

In return-tubular boilers the water level is carried from 6 to 8 in. above the top row of tubes at the front end. The middle try-cock is placed at this level, the lowest cock being 3 in. below the middle and the first cock 3 in. above the middle. The same location with respect to water level applies equally well to water-tube boilers.

There are various conditions that cause priming in a boiler. Perhaps the boiler is being forced too hard, the water level may be too high, or there may be an insufficient amount of steam-liberating surface. Each cause suggests its remedy; the most serious, of course, is an insufficient liberating surface. An efficient dry pipe often aids materially in securing dry steam, but sometimes it becomes necessary to install a steam separator in the line and connect a pressure trap to remove the water separated out.

In cutting in a boiler on a header supplied by several boilers, it is a good plan to slowly open the stop valve, when the gage on the boiler being cut in indicates 3 or 4 lb. less pressure than that in the header. This causes the steam from the header to flow into the fresh boiler, and any water in the branch pipes is carried into the boiler and not into the header, where it might do serious damage. There are three fundamental methods by which water can be supplied to a boiler under pressure:

1. By means of a gravity return, the steam loop, and pressure return trap located on the top of the boiler walls and returning condensed steam and makeup water to the boiler.

2. By means of an injector.

3. By means of a reciprocating pump or centrifugal pump.

In one of the International Correspondence School's books, an interesting and complete discussion of injectors is given, and anyone interested in the subject would do well to read it. The following brief description, however, should give a fairly clear idea of the operation of the injector:

Injectors may be classed as lifting and nonlifting. Those of the nonlifting type must be supplied with water under sufficient head to make it flow to the injector. Of lifting injectors there are two types—positive and automatic. Positive injectors are provided with two sets of tubes—one for lifting the water, the other for forcing it into the boiler. Automatic injectors are provided with a single set of tubes and are designed to automatically restart themselves in case the suction is temporarily interfered with by, for example, the end of the suction hose or pipe becoming uncovered. The old Hancock inspirator, Fig. 1, is a good example of a positive type of injector.

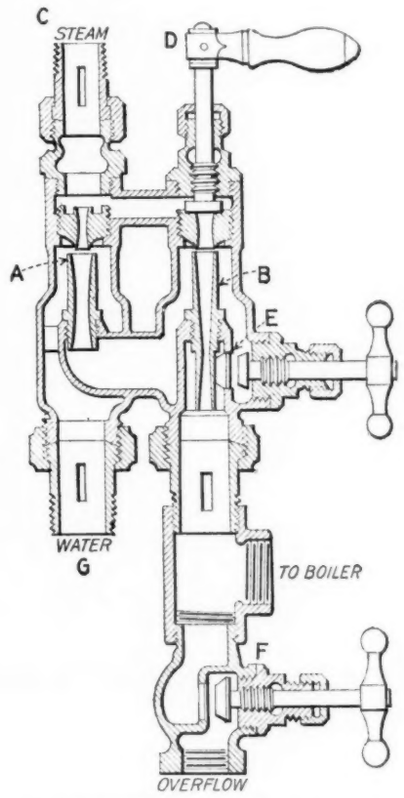


FIG. 1. HANCOCK INSPIRATOR (POSITIVE INJECTOR)

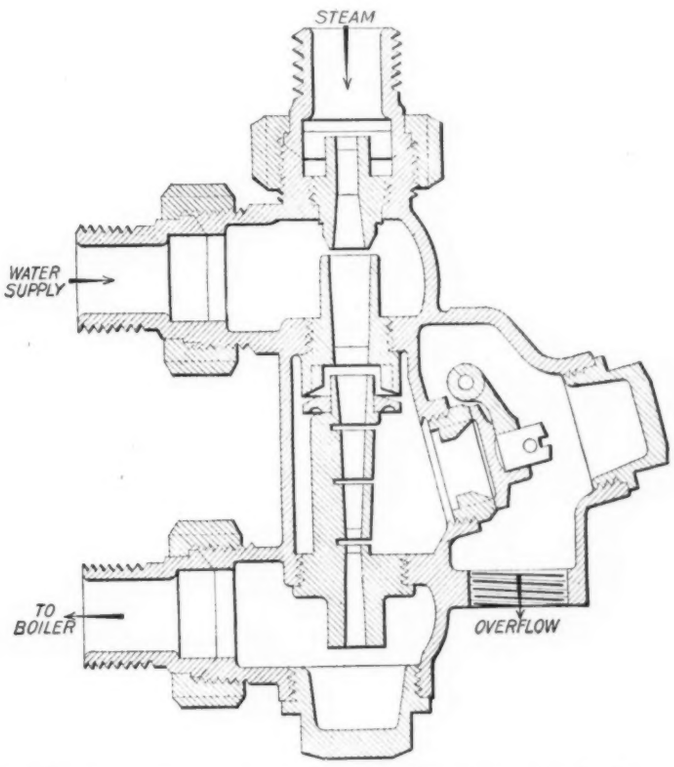


FIG. 2. PENBERTHY AUTOMATIC INJECTOR

As shown in the cut, *A* is the set of tubes designed to lift the water from the hotwell, *B* is the set for forcing the water into the boiler, *C* indicates the location of the main steam valve, *D* is the steam valve controlling the second set of tubes, *E* is an overflow valve bypassing the second set of tubes, *F* is the main overflow valve, and *G* is the location for the valve in the suction. To start this injector, close valve *D* which admits live steam to the second set of tubes, open valves at *E*, *F* and *G*, admit steam at *C*, and when water appears at the main overflow *F*, close *E*, open *D* and close *F*. Adjust the valves until

the water is delivered with the least possible consumption of steam.

The Penberthy injector, Fig. 2, is an example of an automatic injector. As shown in the cut, it is provided with but one set of tubes and has a check valve in the overflow chamber, which is held shut, under normal conditions, by the vacuum in this chamber. Should the vacuum be destroyed, the check valve will open and allow the water and steam to flow out through the overflow. The vacuum in the overflow chamber may be destroyed in several ways: The injector may get air due to leaks in the suction line or to the end of the line becoming uncovered. The water may become too hot by the use of an excessive amount of steam, or the pressure delivered against may become too great. In any event, when the cause of the trouble is removed or corrected, the injector will automatically restart itself.

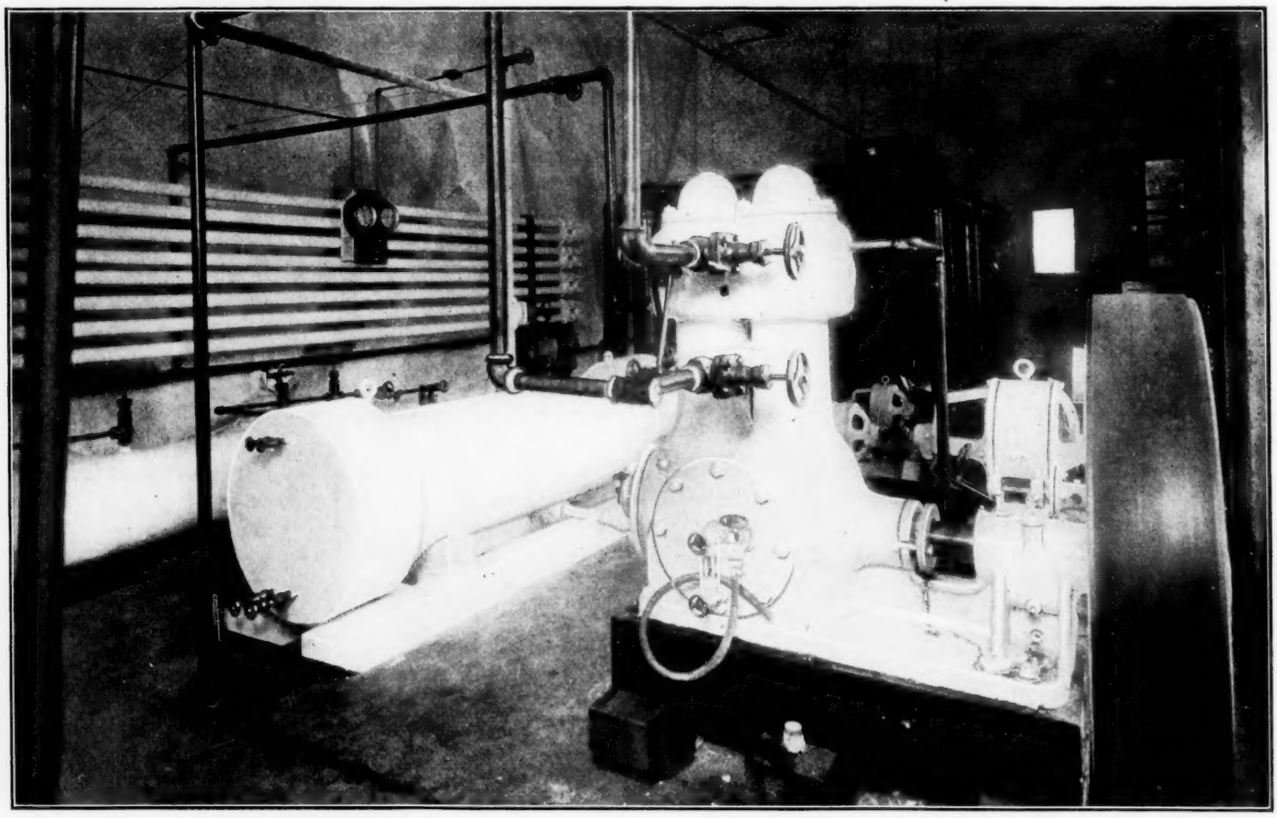
The Penberthy Injector Co. publishes an interesting catalog in which the various causes for an injector failing to work are discussed. A good deal of information can be gained by the study of it, as well as catalogs published by other makers. Viewed from the standpoint of a steam pump, the injector is an extravagant form of boiler feeder. On the other hand, when it is considered that practically all of the steam used is condensed by the feed water, the heat efficiency is nearly 100 per cent.

The use of an injector is limited by the temperature of the feed water, it being difficult to operate an injector satisfactorily with a feed-water temperature much over 100 deg. F.[3] When it is necessary to use cold feed water, an ejector is ideal; it raises the water temperature and prevents injurious strains in the boiler.

[3]The lower the boiler pressure the higher the temperature.

Movable Ice Plant

It is one thing to stage an ice ballet in the New York Hippodrome, where the show runs for an entire season, and quite another to transport a skating rink around the country with only a short run in each place. When it was decided to send the Hippodrome company on the road, keeping intact the entire spectacles of "Around the World," including "Flirting at St. Moritz," the one serious drawback was the problem of furnishing a suitable ice pond. The adoption of the ice plant shown in the illustration proved to be the solution. The various units of this plant are transportable, each being mounted on a skid or stand, so that when the show closes it is only necessary to take down the piping, haul the different pieces of apparatus on a truck, pack them into a car and ship to the next showing place. To prevent the loss of time required to erect the plant and freeze the water, which takes 24 hours, duplicate outfits are used. While one is working in one city, the other is being set up at the next point, so that everything is in readiness when the company arrives.



PORTABLE ICE PLANT ACCOMPANYING PROFESSIONAL SKATING ACT

Each plant consists of a 10-ton compressor, with two cylinders, each 6½x6½ in., driven by a 20-hp. direct-current motor; there also is a 60-kw. motor-generator set. Where direct current is available, the motors are operated from the power circuit, but as usually only alternating current is to be had, the motor-generator set is used to transform the alternating current into direct for the operation of the motors.

The brine tank has a capacity of 1900 gal. The ice pond formed on the stage is 45 ft. long, 20 ft. wide, and 4 in. deep. While being frozen, the water is held in place on the stage by a canvas tub.

Boiler Furnace Temperatures

By George C. Cook*

SYNOPSIS—It is shown that the effect of increased furnace temperature on the heat absorption and efficiency depends on the means used in increasing the temperature, and also that increasing the furnace temperature causes difficulty with the formation of clinker and depreciation of the brickwork and ironwork of the furnace. The advantages and disadvantages of two classes of furnaces are also discussed.

In view of the modern developments in furnace design, a consideration of the temperatures created in the furnace is of interest both to the designer and to the operator. The attainment of high capacities and efficiencies is usually accompanied by high furnace temperatures, and a knowledge of their causes and effects is necessary for intelligent operation.

The term furnace temperature is rather vague, and it might be taken to mean the temperature of either the fuel bed, the furnace walls or the gases before striking the water-heating surface. However, the difference between these temperatures is relatively small and, for all practical purposes, may be neglected.

The union of a combustible material with oxygen is what is known among chemists as an exothermic reaction; that means it is accompanied by an evolution of heat and an increase in temperature.

If carbon were burned in the theoretical amount of pure oxygen necessary for complete combustion and all the heat developed in raising the temperature of the resulting gases utilized, a temperature of 18,000 deg F. would be obtained. In burning coal, however, in a practical furnace, the temperatures are very much lower, owing to the following reasons:

Instead of oxygen air is used to support combustion and almost invariably an excess of air over that theoretically required for complete combustion, giving a much larger weight of gases to be heated. Some of the heat available in the coal is lost by incomplete combustion, by radiation to the surfaces exposed to the fuel bed, by dissociation of the resulting gases,[1] by evaporating and superheating moisture in the coal and in the air supplied and by heating the ash.

For these reasons, the temperature in the furnace of a steam boiler rarely, if ever, exceeds 3000 deg. F. The temperature rise, then, is equal to the calorific value of the fuel minus the losses due to the foregoing causes divided by the product of the weight of gases times their specific heat. An increase in the furnace temperature may be made in the following ways: Using a coal with a higher calorific value, decreasing the amount of excess air supplied, obtaining more complete combustion and decreasing the amount of heat radiated from the fuel on the grates. The furnace temperature may also be increased by preheating the air admitted for combustion.

*Research engineer, Murphy Iron Works.

[1]On the authority of Mallard and Le Chatelier the effect of dissociation is relatively unimportant within the ranges of commercial furnaces.

In connection with boiler-furnace work it will be of interest to note the effect of increased furnace temperature on the heat absorption and efficiency, this effect depending on the means used in increasing the temperature.

If all other conditions are maintained constant but a coal of a higher calorific value is substituted, the total heat absorbed will be higher and the efficiency will be higher since there will be a greater amount of heat absorbed by direct radiation. If the amount of excess air supplied is decreased, or a more complete combustion is obtained, both the heat absorption and efficiency will be increased. If the amount of heat radiated from the furnace walls is decreased, both the heat absorption and the efficiency are increased, but cut down the amount of heat radiated to the water-heating surface and it will be found that both the heat absorption and the efficiency are decreased. Preheating the air admitted for combustion will increase both the heat absorption and the efficiency.

Affecting Degree of Superheat

In the case of boilers equipped with superheaters, changes in the furnace temperature will of course affect the degree of superheat obtained. If the superheater be of the type that receives the gases direct or after passing over only a small portion of the water-heating surface, the degree of superheat will increase with an increase in the furnace temperature, provided, of course, that the velocity of steam through the superheater remains constant. If the superheater be of the type that receives the gases from the boiler after they have passed over all the water-heating surface, an increase in the furnace temperature will result in an increase in the degree of superheat, except when the increase in furnace temperature is due to a decrease in the amount of excess air supplied, in which case the degree of superheat will decrease.

Increasing the furnace temperature is likely to give rise to difficulties from the formation of clinker. Coal ash becomes plastic or even liquid at certain temperatures, depending on its composition. When these temperatures are reached, the ash will fuse and tend to clog the grates, interfering with the air supply and decreasing the rate and efficiency of combustion. This tendency is increased if, in the manipulation of the fire, the ash is raised to the surface of the fuel bed and exposed to the full furnace temperature. If the fuel bed is not disturbed and the ash is allowed to remain below the surface, the ash will be cooled by the air admitted for combustion and may not form clinker, although the temperature of the furnace be greater than its temperature of fusion. This condition is difficult to obtain in practice, however, for when high rates of combustion are desired, considerable manipulation may be found necessary to obtain them.

High furnace temperatures are usually accompanied by increased depreciation of the brickwork and ironwork of the furnace. The fluxing action on the brick of the small particles of ash carried by the combustion gases is accelerated by the higher temperatures, and sometimes temperatures are reached above the fusing point of the brick itself. Another cause of increased depreciation of brickwork with high furnace temperatures is the increase

in the harmful effect of the sudden inrush of cold air currents due to opening of fire-doors, etc. The furnace ironwork also suffers increased depreciation with the higher furnace temperatures to a greater or less extent, according to the care taken in the design to utilize the protection afforded by the ash and the air supplied for combustion.

The temperature of combustion is largely determined by the design of the furnace. The most important features of the design in this respect are the arrangement of brickwork and heating surface, the volume and length of the combustion space and the type of grate or stoker. These items affect the furnace temperature because they control the degree of the completeness of combustion, the amount of radiation and to some extent the amount of air admitted.

Classes of Furnaces

With respect to the arrangement of heating surface, furnaces may be divided into two classes—those in which the fuel bed is directly exposed to the heating surface and those in which the brickwork is so placed as to prevent the fuel bed from "seeing" the heating surface, as for instance, the dutch-oven type of setting. In comparing the two classes the first will give lower furnace temperatures, but at the same time a somewhat higher efficiency and capacity, with various rates of combustion up to the point at which unconsumed gases strike the heating surface, chilling them below the ignition temperature and resulting in heat loss due to incomplete combustion. This seeming paradox of higher capacity and efficiency with lower furnace temperature is explained by the fact that a large amount of heat is absorbed by direct radiation from the fuel bed to the heating surface, resulting in a lower furnace temperature and consequently in a lower gas temperature at the entrance to the tubes. The lower the temperature of the gases entering the tubes the lower will be the exit temperature. A lower exit temperature for the flue gases means that a larger percentage of the heat liberated from the coal has been absorbed by the boiler, giving both higher capacity and efficiency[2].

The counterbalancing disadvantage of this class of setting is, however, that the volume of combustion space is usually less than for the other class exemplified by the dutch-oven type, consequently it is more "smoke sensitive" and its capacity for burning coal with reasonably complete combustion is less. Midway between these two types are the furnaces having their heating surfaces shielded from the fuel bed by arches or baffle tile. In this arrangement considerable heat is radiated to the heating surface from this portion of the brickwork.

The degree of completeness of combustion obtained is an important factor in the temperature developed. In order to have complete combustion, we must maintain the gases above the ignition point and have them thoroughly mixed so that combustion may be complete before they are cooled by the heating surface. The ability to establish this condition is largely dependent upon the design. Often, in hand-fired furnaces various devices, such as arches, brick piers, wing walls, air and steam jets, are installed to accelerate the mixing of the gases. These are usually successful in improving the combustion but their maintenance is high and as they increase the loss in draft through the boiler, they decrease the capacity that can be obtained with a given draft.

What the volume of combustion space and the length of flame travel should be is an important question and many installations of the past owe their lack of success to neglect to make ample provision in this respect. The necessary amount of combustion space to insure reasonably complete combustion is dependent upon the type of furnace, the rate of combustion and the amount of volatile constituents in the coal. There is little exact information available on this subject, and the designer should be governed in his design by a consideration of successful installations having similar conditions to the one contemplated.

It is of the utmost importance that the materials of which the furnace is constructed should be especially chosen to meet the proposed conditions with respect to character of load, furnace temperature, and character of coal particularly with respect to the composition of its ash. For example, with reference to the selection of firebrick, where there is a steady load and the ash of the coal burned does not exert an appreciable fluxing action on the brick, any good grade of firebrick whose fusing temperature is greater than the maximum furnace temperature obtained would be satisfactory, if properly installed and given reasonable care. Where the fine ash carried through the furnace by the gases exerts a fluxing action on the brick, the brick used in that part of the furnace exposed to this action should be especially chosen for its ability to resist this influence. In many cases the ash in the fuel bed itself exerts a very destructive effect on the brickwork exposed to its influence. Where the load is exceedingly variable and where sudden inrushes of cold air into the furnace cannot be avoided, heavy stresses are set up in the brick, which call for a brick mechanically strong and with a minimum tendency to spall.

In the operation of the boiler plant it should be borne in mind that it is sometimes possible to obtain economy in the cost of fuel at the expense of excessive depreciation of the installation, and an endeavor should be made to strike such a balance between the two that the true cost will be a minimum. As an example, the writer has in mind a plant in which the operatives, in the desire to carry a high CO_2 percentage, developed a furnace temperature above the fusing point of the firebrick, and as a result, the brickwork failed in a few weeks' time. By making a small sacrifice in efficiency, this condition was overcome and steam was generated at a lower cost and without trouble due to shutdowns.

[2]See Technical Paper No. 34, United States Bureau of Mines.

In Gasoline Measuring Systems of Various Types, numbering 79 in one set of tests by the Bureau of Standards[1] chosen at random in a number of different cities, 55, or 70 per cent., had errors in excess of the tolerance allowable, and 24, or 30 per cent., had errors within the tolerances. In addition, there were eight outfits so constructed as to be absolutely unsuited for retail liquid dispensing. Of the 55 out of tolerance 80 per cent. gave deliveries in deficiency and 20 per cent. in excess. This tendency toward deficient measurement is worthy of careful consideration, and it is only proper to call attention to the fact that most of the causes of error in measuring-pump operation tend toward the side of deficient delivery. Among these may be mentioned leaks, retention of liquid by the hose, excessive virtual suction head, resulting in vaporization and other losses, failure to complete the full stroke, and slippage.

[1]Technologic Paper No. 81, "Liquid Measuring Pumps," by F. J. Schlink.

CO_2 Recorders and Their Value

By Victor J. Azbe

SYNOPSIS—Useful information on the installation and working of the CO_2 recorder based upon the knowledge obtained from installing six recorders of three different types and operating them continuously for two years.

In most boiler plants great quantities of fuel are wasted and the chief loss is that due to excess air. In many plants this loss is 18 per cent. (7 per cent. CO_2), and in some it is as high as 23 per cent. (6 per cent. CO_2). In well-operated plants the loss is ordinarily about 6 per cent. (12 per cent. CO_2), and there are some few exceptionally well designed and operated boiler plants where it is only 1.5 per cent. (16 per cent. CO_2).

To determine the loss due to excess air, flue-gas analyzers are employed, of which there are hand-operated and automatic recording types. The first ordinarily is an Orsat or one of its modifications; the second, one of the several different types of recording instruments on the market. A hand gas analyzer is a useful device, and every boiler plant, no matter how small, should have one for testing purposes. The instrument is simple, but as its operation requires considerable time and the information obtained is not immediately visible to the fireman, its value is reduced. An automatic recorder, on the other hand, shows from 10 to 20 times every hour what quantity of CO_2 is in the flue gas, and it operates continuously, thus enabling the chief engineer to know how careful or careless his firemen were during the night.

Interest the Firemen

It is ordinarily maintained that considerable knowledge is required to understand what the CO_2 recorder shows. This is not so. Post the CO_2 recorder conveniently for the fireman, let him know that the higher the CO_2 obtained the better fireman he is, and explain further that the higher the CO_2 the shorter will be the red line drawn by the recorder pen (or longer, depending upon the type of instrument). This is all that is necessary, except occasional suggestions on how to handle the fires to obtain a higher percentage of CO_2. In the next few weeks it will be surprising how the CO_2 will increase, especially if the firemen are placed in competition with one another by posting their results conspicuously upon a blackboard. The fireman himself will soon gain confidence, since he will see that when the fires are bad, the recorder pen strokes upon the chart will be long; when the fires are good, the ink lines will be short. It is important after he once gains this confidence that the recorders be kept in good condition and in proper operation; otherwise he will lose faith in the readings.

Improper installation, ordinarily, is the chief reason why, in so many plants, recorders are not a success. The water to the recorder must be clean, which means that any free matter must be given a chance to settle and be filtered out. The gas lines, which give the most trouble, must have the proper pitch, with no pockets, and be of the proper size. At the boiler there should be a gas filter with excelsior and cloth as filtering material, which should be changed at frequent intervals. No cocks should be allowed in the gas line; in their place oil seals should be used. Brass cocks become corroded and leak. Gas lines should be installed with the greatest care and when completed should be put under compressed-air pressure to test for tightness.

The sampling tube in the boiler uptake does not need to be of complicated design, since it is impossible to make one that will sample gas evenly throughout the whole width and length of the uptake opening. A straight tube, such as is shown in Fig. 1, is all that is necessary. The small openings prevent the tube from becoming stopped up with soot accumulations. The position of the tube is important, and care must be exercised to have the openings placed in the center of the main gas path. If they are inserted in a dead space, lower CO_2, sometimes 3 to 4 per cent. less, will be the result.

After proper installation of the water and gas lines, the CO_2 recorder itself will give little trouble. Whatever

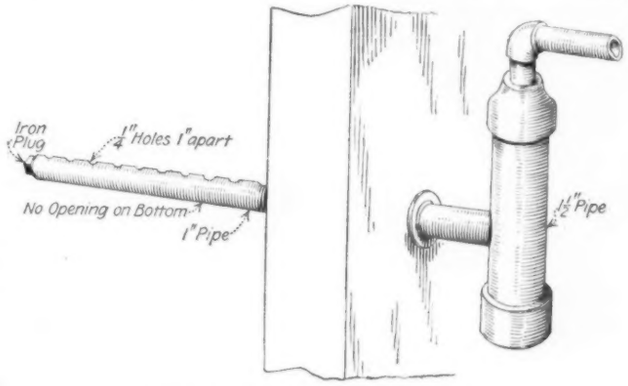


FIG. 1. GAS-SAMPLING TUBE

defects arise are of a minor nature and easily remedied. The reason why so many recorders are idle or have been thrown out of the boiler plant is because the man who had them in charge did not know their principles of operation. Usually, CO_2 recorders are designed and operated upon the simplest principles of physics, and if a man knows that water will not flow uphill without some reason, that gas is lighter than water, what causes the siphon to operate and a few other such simple facts, and he takes time to learn thoroughly the duty of the different recorder parts, then he will be competent to keep the instrument in proper operation without spending on the average more than ten minutes per day per recorder.

With proper adjustments, the care they require, besides changing the chart and renewing the solution, is slight. Their accuracy, with the solution changed at proper intervals, is all that is required for practical purposes. Of course, if there is the slightest leak in the gas line, the value of the recorder becomes nil, but this cannot be accepted as the fault of the recorder and can be remedied. The leak can be found by putting the line under pressure or by taking a sample of gas with a hand instrument at the boiler and comparing the result of its analysis with that of the recorder.

The cost of CO_2 recorders varies, but there is one made that sells for $180 and it is as satisfactory in operation as any other. The cost of upkeep is slight except for

the caustic potash, which at the present time, owing to prevailing war prices, is quite high, requiring about $30 worth of this chemical per year per recorder. In normal times the cost is less than one-tenth of this amount.

The life of the recorder depends upon the care it receives, but it should last about five years. At the end of this time it can be overhauled for about $50 and made fit for another five years. The amount of water required varies from 250 to 500 gal. per day.

The return on the recorder investment depends upon the price of fuel, the amount burned and the saving effected, but it can be safely accepted that hardly any other apparatus will give a greater return. In large boiler plants savings as high as $15,000 per year have been made, all going to the credit of the CO_2 recorder. In small plants the saving will be proportional and will range from 5 to 15 per cent. of the total fuel bill.

The question is often asked as to whether it is best to install a recorder for every working boiler, or only one instrument for the whole plant. The first recorder installed will produce the largest saving, since it will act as an instructor on how to fire the boilers efficiently. Having one instrument for each working boiler is, of course, desirable, since with such a system all firemen are under complete check and can be put under competition. Also the boilers are operated more evenly, because with one recorder only, the fireman is liable to take good care of the boiler to which the recorder is connected and neglect the others.

As far as the boiler is concerned, an objection to the CO_2 recorder is that the fireman often tries to obtain

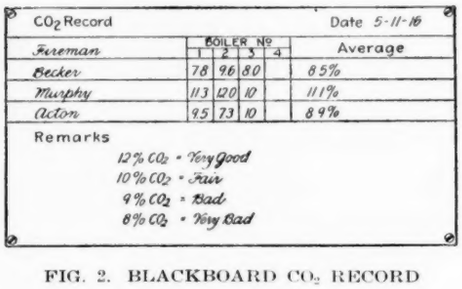


FIG. 2. BLACKBOARD CO_2 RECORD

too high CO_2. High CO_2 is accompanied by high furnace temperature, and there is a point where depreciation of the furnace lining will offset the saving effected. This point must be determined and the CO_2 percentage maintained under it. Every plant should have its own standard, which should be determined after considering all factors, the chief of which are slagging effect and incomplete combustion, both being controlled by furnace design. The standard in one plant might be 10 per cent., and in another plant of uptodate design it might be as high as 16 or 17 per cent.

Fig. 2 shows a blackboard design on which to post firemen's CO_2 percentages. This record system can be elaborated, and at the same time complicated, but the form shown will be found simple and effective. When greater accuracy is desired, it would be advisable to post the corresponding fuel loss instead of the CO_2 percentage, as the fuel loss is not directly proportional. For example, raising the CO_2 from 8 to 9 per cent. will cause a fuel reduction of 3.3 per cent. while raising it from 11 to 12 per cent. the saving will be only 1.8 per cent. The loss could also be expressed in percentage considering the maximum CO_2, or the standard for the plant as 100 per cent., the minimum allowable as 0 and determining the intermediate points from the fuel-loss table. But there is danger that if the system is made too complicated for the fireman to grasp, he well lose interest, and of course this is what is not wanted.

Herewith is presented a table showing the fuel loss at different CO_2 percentages, based upon a flue temperature of 600 deg. F. For any other temperature it will be necessary to multiply by the correction factor given.

FUEL LOSS DUE TO EXCESS AIR

CO_2, %	Pure Carbon OH, %	Bituminous Coal, 3%H, %	Fuel Oil, 10%H, %	Natural Gas, 70%H, %
21	0	....	....	....
20	0.2	....	....	....
19	0.7	0.2	....	....
18	1.6	0.8	....	....
17	2.7	1.6	....	....
16	3.3	2.5	0.2	....
15	4.6	3.5	1.0	....
14	5.9	4.5	2.0	....
13	7.2	5.6	3.2	....
12	8.5	7.1	4.6	....
11	10.2	9.0	6.0	....
10	12.5	11.3	7.5	....
9	15.5	13.7	9.6	....
8	18.7	16.9	12.5	....
7	23.7	21.3	15.6	....
6	29.3	26.2	20.0	....
5	36.7	30.5	26.2	....
4	49.3	45.0	34.3	....
3	68.7	62.5	50.0	1.5
2	....	....	78.7	7.1
1	....	....	....	22.5
0.5	....	....	....	50.0

CORRECTION FACTOR

Temperature	450	500	550	600	650	700	750
Factor	0.7	0.8	0.9	1.0	1.1	1.2	1.3

Gas analysis is considered by the best engineers as the most convenient and effective method of checking boiler-room performance. It is something that will stay with us in the future and will be more generally used than at present. Such statement by engineers as, "We don't want CO_2, we want steam," is ridiculous. An erroneous impression prevails that to maintain high CO_2 it is necessary to close the damper. Of course it is more easy to obtain high CO_2 with low draft than with high, nevertheless as high a percentage can be maintained with the latter condition if the fire is in the proper condition. As far as steam is concerned, there will be more of it generated with a given draft and high CO_2 than with low CO_2.

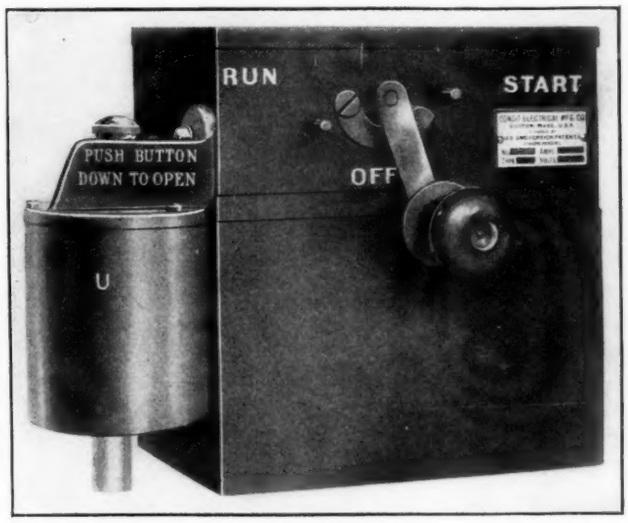
An Oil-Immersed Starter for Small Induction Motors

It is a fundamental engineering principle that for safe and satisfactory operation, as well as for economical maintenance of the apparatus, the making and breaking of an alternating current should take place in oil, irrespective of capacity or potential. Because of the heavy starting current taken by induction motors when they are thrown directly on the line, it has been customary to use fuses the capacity of which was far in excess of the normal running current. Thereby the motor was afforded no overload protection under running conditions.

A fused oil switch for use in starting small induction motors that are thrown directly on the line without the use of a starting compensator is shown in the figure. This switch is equipped with an undervoltage release *U*, which allows the switch to come to the off position in case of low voltage. It is built by the Conduit Electric Manufacturing Co., South Boston, Mass., and is known as their Type I oil starter. The switch may be used successfully

under any of the conditions met with in actual practice, provided the starting current of the motor which it is intended to control does not exceed 50 amp. at 440 to 600 volts, or 100 amp. at 110 to 220 volts. When properly installed, it affords complete protection to the motor against overload, single-phase running, short-circuits or failure of voltage.

The fuses are located inside of the case on the terminal board and are cut out of circuit when the operating lever



STARTER FOR SMALL INDUCTION MOTORS WITH AN UNDERVOLTAGE RELEASE

is thrown to the starting position and into circuit when the switch is in the running position. This permits the motor to be fused for proper overload protection without blowing the fuse when starting. The starter is totally inclosed; consequently there is no danger of the operator coming in contact with either the operating mechanism or any live parts, therefore the device meets the safety-first requirements which are of such vital importance in the present industrial field.

A Peculiar Transformer Trouble

By Leonard Kennedy

Large high-voltage water-cooled transformers are now coming into such general use that everyone connected with the operation of central-station or electric-supply systems may have to locate operating troubles at one time or another. A large water-cooled transformer was installed in a station already containing one of similar design and ordered upon the same specifications. Both units were apparently identical, having the same values of resistance and reactance (upon which the regulation depends), the same rating and voltage. At first both ran within safe and prescribed temperature limits and shared the load equally when operating in parallel. After about six months' service, however, complaint was made that the transformer installed last would not carry its share of the load. When first parallel with the other transformer, it took half the load, but slowly and surely began to shirk.

This phenomenon is suggestive of poorer regulation of the transformer carrying the smaller load, but tests made when the unit was installed showed that the regulation of both was the same. A current transformer and ammeter inserted between the two units showed that there was little circulating current between the two. The regulation of two transformers varies inversely as their respective impedances, consequently, with a load of high power factor the resistance component of the impedance plays the more important part as to regulation; whereas, when loads of low power factor are being carried, it is the reactance which is the important component. Knowing this, one might come to the conclusion that the two transformers took different portions of the load when the power factors differed, but since both had the same values of resistance and reactance, this theory does not hold. Measurements of the resistance and reactance of both windings when hot and cold showed that the one that shirked its load attained a higher temperature than the other, hence the regulation would be worse by reason of the higher resistance. The possibility of a bad joint suggested itself, but the resistance of the two units being the same when cold discredited this.

Thermometers were then placed in the oil of both units and measurements taken at frequent intervals. The oil of the transformer that shirked its load was found to be about 40° C. higher than the oil of the other transformer, although its load was less. The higher oil temperature was of course due to higher temperatures somewhere in the transformer; the resistance of the winding also increases with increasing temperature, owing to the temperature coefficient of copper, and the regulation becomes impaired.

Temperature of the Cooling Water

The cooling water flowing through the two transformers showed that although both were receiving the same quantity of water per minute, the transformer with the hotter oil gave a lower temperature of its cooling water after it had passed through the cooling coils. It was obviously a case where the cooling coils of the one transformer were not functioning properly; that is, the heat transfer from the hot oil to the cooling water was not occurring to the extent that it should.

As the quantity of water passing through both coils was the same under the same pressures, there could hardly be an obstruction in the cooling coil; if there was, the temperature of the water coming out would be higher, and the quantity also less, because of the constricted pipe area. Scale or sediment might form in the coil from impure water, but then why in the one coil and not in the other, since both coils were made of the same material? Such might occur had the transformer been placed in service with the cooling water turned off until the stagnant water imprisoned in the coil evaporated and, in so doing, covered the coil with a thin film of scale equivalent to that in a boiler, having heat-resisting or insulating qualities. This was hardly likely, however, and the possibility of such a thing occurring was emphatically denied by the operators.

The trouble was so clearly due to faulty cooling coils that it was decided to remove them for examination. The oil was drained off, and the coils were taken out. The first couple of turns were clean and normal, but the lower ones were covered with a thin film of slime, or paste, much like vaseline only darker in color. This sticky film was uniformly distributed along the coil, being somewhat thicker at the bottom of the coil and getting thinner toward the top turns. This sludge had

apparently no effect upon the brass of the coils, for there was no sign of corrosion or discoloration after the slime had been wiped off. It was, however, a very good heat insulator, as experience had already proved.

As the coating had formed in so short a time (about six months) it was suggestive of two things—either that the transil oil used was extremely impure, the impurities being precipitated down upon heating or that the transil oil or some of its constituents acted as a solvent to attack the impregnating compound used to insulate the windings. The surface of the cooling coils showed no sign of corrosion, as they probably would, had the oil been impure. The oil was of a standard and reliable brand and was the same as that used in the other transformer, which had given no trouble. Experiment showed that the oil did act as a solvent for the impregnating compound. This compound was not readily soluble in the oil except at the higher temperatures, such as would be enhanced by the absence or ineffectiveness of cooling water. While the original cause of the high temperatures and the initial coating of sludge was not determined, no further trouble has been experienced since the coil was cleaned and operating temperatures maintained within safe limits. The evidence, therefore, points to the unit having operated at a very high temperature at some time or other.

Removing Concrete Foundations

By H. G. Burrill

The removing of old concrete foundations in power plants is a more or less difficult problem, especially where the use of dynamite is prohibited by reason of surrounding machinery. In such cases plugs and feathers must be resorted to.

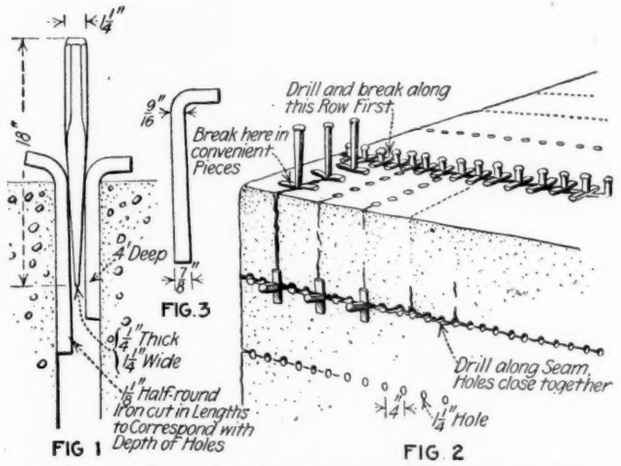
In the first place it is necessary to determine if possible the age of the foundation. If fifteen or twenty years old, it may reasonably be assumed that the concrete was placed in layers. This we deduce because at that time concrete was practically all hand-mixed and not more than 50 or 60 yd. was customarily placed per day. Thus there must be a seam in the concrete, at which surface it will split apart most readily. To find this seam, examine the outside walls carefully. If a porous spot is found where the grout has run out and left the stone exposed, and if this runs along in a straight line below which there is a comparatively smooth surface, it is safe to assume that a seam has been found.

Another way is to drill and break off a corner, and if the foundation is oil-soaked, it will discolor the seam inwardly for three or four inches, furthermore, the chunks will break in two at this point.

After the seam has been located, drill a series of 1¼-in. holes 3 to 4 in. apart along the seam to a depth of about 4 ft., bearing in mind that the drill removes a large area of the bond and must be used freely. Place the plugs and feathers, with the long feather of half-round iron on the bottom and the short one on top, in every other hole, put in a plug or wedge and drive all wedges as nearly simultaneously as possible, using 8-lb. sledges in the hands of good strikers (eight holes per man is sufficient). See that every wedge is kept hard up and that an even tension is kept on all. After the crack starts, drive the plugs nearly up to the heads, then double up, placing two wedges in a hole and raise the slab about half an inch and remove all but a few wedges. Next take the slab already lifted and quarter or slice it off (Fig. 2), again quartering until small enough to be handled either by men or by a crane.

In case speed is desired and a crane is available, slabs averaging about 3 cu.yd. may be removed with the crane and rollers, to be broken up outside later. Use running water when drilling with compressed air, as concrete dust is injurious to engine and machine bearings.

Should there be no seam, good results can be obtained by drilling holes closer together and deeper if possible, always remembering that each foot in depth of the drill



FIGS. 1 TO 3. WEDGES, FEATHERS AND THEIR APPLICATION

holes lowers the resistance of the concrete to the extent of 3600 lb. (based on a tensile strength of concrete as 200 lb. per sq.in.). Keep the drill sharp, use running water, have at least two good hammermen and one good jackhamer drill runner. A 4-ft. drill is about right.

Figs. 1 and 2 show the tools and the methods of applying them. Plugs and wedges should be made of tool steel and left soft. Feathers should be made of ⅛-in. half-round iron, bent over as shown.

When there is concrete to be cut and no seam can be found, make a short feather, as shown in Fig. 3, by upsetting the end and tapering to correspond with the wedge. Make the taper of the wedges ⅜ in. to the foot, leaving then ¼ in. thick on the small end. The stock should be of 1¼-in. octagonal tool steel.

JUST FOR FUN

Almost Bruised Him

The Springfield *State Register* recently published the following account of a boiler explosion:

Taylorville, Ill., Dec. 22—An explosion of the boiler at the Orat Home Milling Co.'s plant at 9:30 o'clock Friday morning ripped a 6-ft. gash in the bottom of the boiler, hurled it off its base, caught Walter Harlan, the engineer, under a mass of bricks and débris alongside the wreck and almost bruised him. The explosion tore loose the piping leading to the boiler from above and jarred down parts of the brick wall of the boiler-room annex. Harlan was uninjured.

Some engineers are lucky, but Harlan may get his shins knocked the next time, so be careful, Walter.

Work in Dynamics is denoted by the product of a force multiplied by the distance through which it is exerted, both being measured in the same direction; energy is the ability to do work, but is measured in the same unit as work.

Editorials

Henry Gordon Stott

The world of engineering has lost a Cæsar. Henry Gordon Stott, as superintendent of motive power for the Interborough Rapid Transit Company, New York City, whipped into shape one of the most gigantic and complex power systems of modern times. He held this position when he died January 15.

It is not because he attained unusual success as layer of ocean telegraph cables; or in the installation of underground electric cables on two continents; or because he was in direct charge of the design, construction and operation of the power-generating stations and distributing systems of the subways, elevated and surface cars of New York; but because he was a daring pioneer in the mechanical and electrical divisions of the art, that he is distinguished.

When he returned from Madrid, Spain, in 1891, he shouldered the responsibilities that went with the design and construction of the electrical system of the Buffalo Light and Power Company, now the Buffalo General Electric Company. Ten years later came the huge task of developing the modern electrification of the elevated and surface lines of New York, soon followed by the subway systems. Most of the work in Buffalo and New York was new; the magnitude of it called for originality and initiative; precedents had to be made, not found.

It was under his direction that the last of big reciprocating steam engines were installed—last because the steam turbine was soon to make its successful début. These were the 7000-horsepower Manhattan-type units at Seventy-fourth Street Station, too well known to here discuss them. When the rapidly increasing traffic in the subway system in 1908 called for a considerable increase in power for the winter of 1909-10, Mr. Stott, rejecting the reciprocating engine because of its high first cost and small range of economical operation, installed low-pressure turbines on the exhaust end of the 7500-kilowatt, maximum rating, engines already in service. This was perhaps the most notable low-pressure turbine installation ever made, and the economy performance of the combined units long remained the record achievement. One hundred per cent. increase in capacity was had with but twenty-three per cent. increase in water rate; there was thirteen per cent. increase in economy over the performance of the best high-pressure turbine of the time; twenty-five per cent. improvement between 7000 and 15,000 kilowatts over results with the engine unit alone; and the unit thermal efficiency between 6500 and 15,000 kilowatts was 20.6 per cent.

Recognizing the many advantages of operating boilers at ratings considerably above normal under commercial conditions, Mr. Stott was one of the first, and likely the first to attempt the practice. His double stoker setting at the Fifty-ninth Street power house has been an object of great interest wherever engineers perform their tasks.

Stott was a pioneer advocate of large turbo-generating units. When Francis Hodgkinson placed before him the idea of the cross-compound turbine, he recognized the flexibility of operation and its other advantages. Stott was the first to install this type of machine and since ordered one of 60,000 kilowatts maximum rating.

Seeing little hope for improvement of plant economy by new types of prime movers, Mr. Stott favored the trend toward extremely high boiler pressures and superheat. While planning the new River Station of the Buffalo General Electric Company, he seriously considered using 1000 pounds steam pressure, though happily he compromised by getting a high total temperature at most reasonable cost through the use of 275 pounds pressure and 275 degrees superheat.

Not only was Mr. Stott unusual as a pioneer, but he was a rare combination of the theoretical, practical and executive engineer. He deserves a foremost place among the notable engineers of modern times.

What Next in Automatic Control?

When the first remotely controlled synchronous-converter substation was put into operation four years ago, it was considered no small engineering feat. Since then several automatically controlled converter substations have been put into service, one of these being a portable outfit. It has been general practice for many years past to operate motors of all sizes in various applications, with very little attention, the control being either remote, as in elevators, steel mills, etc., or completely automatic, as the starting and stopping of pump motors by the use of a float switch or compressor motors through the medium of a pressure regulator. In the latter case, if the electric motor had not been a reliable piece of equipment, it would have failed from lack of attention.

However, up to four or five years ago it was considered necessary to have an attendant in all synchronous-converter substations. This opinion was justified by the early performance of this type of equipment, which was rather an uncertain factor. The improvement that has been made in the design of this kind of apparatus in recent years has made it as reliable as any direct-current machine, therefore it no longer needs the attention of an operator. As far as the protection of the machine is concerned, the operator might just as well be a mile away as alongside; because, if suitable protection is not provided for the machine against short-circuits, reverse currents, overspeed, etc., it would be destroyed before the man would have time to make up his mind what to do to relieve the equipment or what machine the trouble was on. On the other hand, the attendant must depend upon the reading of voltmeters and ammeters for the adjustment of the machines, and when to cut them in and out of service. Therefore, it is just one step farther to make the instruments contact-making devices, and the control then, through suitable equipment, can be made automatic.

The automatically controlled substation so far has found its greatest use for railway work and seems to be

the one logical solution of the problem of economical distribution of direct current to interurban railways. For light and power purposes the field of application for this type of equipment does not look so promising, since in recent years alternating current is seriously contesting the direct-current system for general industrial service with the exception of electrolytic work. Nevertheless, the automatically controlled converter substation was the forerunner of the automatic synchronous-condenser substation, one of which was recently put into operation. This makes it possible to locate these machines to the best advantage on the transmission system, where, when the voltage drops below a certain value by reason of heavy wattless currents, the condenser is cut in automatically and corrects the power factor of the system and is cut out again when not required. This latter machine is of high voltage and capacity, therefore, when the control systems in the modern power plants are considered, is it predicting too much to prophesy the automatic control of networks of power houses and transmission systems?

An Incentive for Firemen

That it is folly to build a new steam plant and then hire an incompetent engineer to operate it is axiomatic. But what applies to a steam plant as a whole also applies to a boiler plant as a unit of the whole. Although the best-designed stokers may be installed and the furnaces may be built in accordance with the most advanced practice, all goes for nothing unless the men who operate them understand their business.

For instance, if the fireman operates a chain-grate stoker properly, the fuel will have been consumed by the time it reaches the rear end of the grate. On the other hand, if he is careless, ignorant or indifferent, the stoker may be so operated that much of the rear surface of the grates is covered with ash through which excess air passes to the furnace, or the fuel bed may be so thick and the feed so fast that fuel is carried over into the ashpit before it has a chance to be completely burned. The first condition will, of course, result in low CO_2 in the furnace gases, a loss in economy, and the second will be a needless waste of fuel.

Certain types of stokers have dumping plates and if live fuel is allowed to accumulate on them, heavy clinker is pretty sure to result. When necessary to clear the fires, the clinker will not fall past the dumping plate when the latter is operated, and the plate is either slammed in an endeavor to dislodge the mass or a bar is used to loosen it. Either will result in more or less fuel falling into the ashpit. This is a loss that a careful fireman can keep down to a minimum.

In the average boiler room there is little to stimulate the firemen to do better work. They are often dark, hot and dirty, and sometimes not fit places for a human being to work in. It is no wonder, then, that the fireman no sooner comes on watch than he begins to look for quitting time. He merely holds his job because of the pay that provides his family with necessities. He knows that he will receive the same amount on payday week after week and no more, whether or not he has allowed excess fuel to go to the ashpit or excess air to the furnace. Furthermore he knows that a poor fireman will receive the same pay as a good one. So why do any more work than is absolutely necessary?

Rivalry among firemen has in many instances produced splendid results, but it is likely to stimulate to better work for a time only, for it does not buy shoes for the children, a new hat for the wife or even a ten-cent plug of tobacco for the fireman himself. If a chief desires to maintain the interest of his firemen in their work, he is more likely to achieve results if he evolves some plan that will put extra money into their pay envelopes.

This extra pay cannot be determined by the amount of coal burned, because main strength does not mean economy. It is not the amount of coal consumed that counts, but the amount of water evaporated per pound of coal burned. In general, the better the combustion, the higher the CO_2 and the more water evaporated.

If such a bonus system should be taken up in the operation of the boiler plant, the fireman would not do his work with his eye on the clock, but his mind and vision would be centered on getting the largest cash bonus possible and his aims would all be to that end.

The Paramount Issue

In the December first issue of the London *Electrical Review* was published an article of considerable length enumerating breakdowns that had occurred in German-constructed power plants in various parts of the world. The apparent causes of these troubles were also pointed out and comments made on the superiority of American and British machinery. This is very interesting and should prove of great value when used to the proper end. The real value of this article seems to be very aptly set forth in a comment on it in the December twenty-third issue of that periodical, in which the author says in part:

> With reference to your comment on "Breakdowns of German Plant," in your issue of the first instant, while agreeing with the same, I think the end desired will never be attained until our own manufacturers wake up to the fact that they owe something more to their customers than merely delivering the goods. Complaints of faulty workmanship or working should receive prompt attention, and any alterations found necessary should be carried out in a speedy manner and not at the expense of the customer; especially should that be done where manufacturers have turned their attention to new types of plant of which they have had no practical experience.

After commenting upon the fair dealing that the writer had received from foreign manufacturers (not German) and the unsatisfactory experience with one of his home manufacturers, he points out that when English manufacturers wake up to their responsibilities they need not fear German competition.

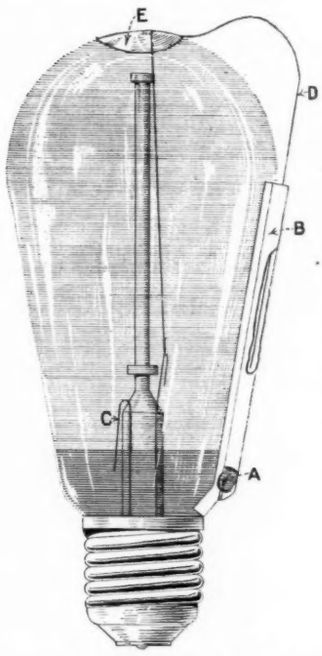
This is the real issue for the American manufacturers to keep in mind—that they owe something more to their customers than merely delivering the goods. To a very large degree the manufacturers recognize this fact in their home market, but it is to be regretted that in many cases a different code of ethics is used in business transactions with foreign customers, and an endeavor is made to justify these dealings by pointing to the faults of others.

It may be all right to observe the shortcomings of one's competitors, but it is of little effect wasting time and energy talking about them, and in general those who do the most shouting are the ones who may with profit to themselves consider their own deficiencies. What will produce lasting results in our foreign markets is an awakening of the American manufacturers to their responsibilities to their customers and an honest endeavor not only to deliver the goods, but to see to it that they meet the purpose for which they were intended.

Correspondence

A New Use for Old Lamp Bulbs

The contact-making thermostat shown in the figure depends on the contraction and expansion of air in a bulb forcing mercury up a tube and closing an electrical circuit. A ⅛-in. hole *A* is made in the bulb of a 25-watt Mazda lamp near the base. A tube *B*, consisting of shellacked paper, is then formed on the side of the bulb, with the upper end open and the lower end leading into the bulb through the hole *A*. The next step is to grind off the tip of the bulb and by means of a No. 14 wire inserted in the opening, the leading-in wires from the base are bent, one straight down and the other with a hook, as shown. A piece of No. 22 wire, with a loop on one end is looped over the hooked leading-in wire and then drawn up through an opening in the top of the bulb and allowed to extend out about 4 in. The top opening is now sealed over with a piece of shellacked paper *E*. Enough mercury is put in the bulb so that the leading-in wire *C* dips into it ¼ in., then the lamp is screwed into a receptacle, and wire *D* coming from the top of bulb is bent down into tube *B* so that the circuit will be closed at the desired temperature.



LAMP-BULB THERMOSTAT

A contact, sliding in clips, may be used instead of the bent wire if a more elaborate arrangement is wanted.

Easton, Penn. C. V. HAWBECKER.

Indicating Boiler Performance

In the article, "Draft and Its Application to the Steam Boiler," in the issue of Nov. 21, page 711, Mr. Uehling makes a statement which, though correct in itself, is apt to be misleading. Though boiler draft is an index to the rate of steaming of the boiler, it does not follow necessarily that it is a true indication of such or that it may be depended upon to show whether each boiler is doing its share.

The steaming rate of a boiler depends not only upon the rate of combustion in its furnace, no matter how perfect that combustion is, but also upon the ability of that boiler to absorb the heat resulting from that combustion; and this in turn depends largely upon the condition of its heating surfaces. A clean boiler will steam at a higher rate than a foul one, therefore with the draft the same in both cases, it would not be a correct index as to output. If a given boiler operating with a draft *A* had its combustion rate increased until, with the same efficiency of combustion as before, the draft became *B*, then the boiler draft would be an index to the steaming rate as compared to the steaming rate corresponding to the first draft; but unless a meter indication of the rate of steaming was taken at *A*, the index *B* would be of little value as an indication of steam output.

The specific object is to obtain steam under certain prescribed conditions. If it is to be at 150 lb. pressure, a pressure gage is used to determine it. If it is to be at 100 deg. F. superheat, a thermometer is also used to show the temperature. If there is to be a certain quantity, a steam-flow meter measures it. Then, knowing what the boiler is producing, we strive after efficiency in the production and apply the CO_2 apparatus, the draft gages and the coal-measurement devices to check its performance in that respect. H. A. HOFFMANN.

Philadelphia, Penn.

Vertical Boiler-Head Covering

In the issue of Dec. 26, 1916, page 896, Mr. Westman asked about material for covering vertical boiler heads.

In the plant where I am engineer we have three 250-hp. vertical boilers about 7 ft. in diameter at the top. Up to the first of 1916 there had been no satisfactory covering found, but I then placed on each boiler two inches of asbestos mixed with water and on top of this a fine-mesh chicken wire and a 1½-in. layer of asbestos and portland cement, half and half. This made a very durable surface, which has withstood severe treatment and heavy wear due to men walking and dropping heavy tools on it. The covering is as good now as when first put on and bids fair to last several years, and the heat radiation is very small. R. A. PACKARD.

Little Falls, N. Y.

Polyphase Wattmeter on a Single-Phase Circuit

In the Nov. 28 issue of *Power*, page 765, I note the explanation of measuring single-phase power with a polyphase wattmeter, and I assume that the idea is to use only one element of the instrument. I find in practice that the method more frequently used is to connect both current windings of the polyphase wattmeter in series with the circuit and both potential windings of the wattmeter in parallel across the circuit. The scale reading should then be divided by 2 to obtain the correct power in the circuit.

The advantage of this method is that full-scale deflection of the needle can be obtained, and the scale can therefore be read with greater accuracy.

With only one element of the wattmeter being used, it would not be wise to have the needle deflect more than

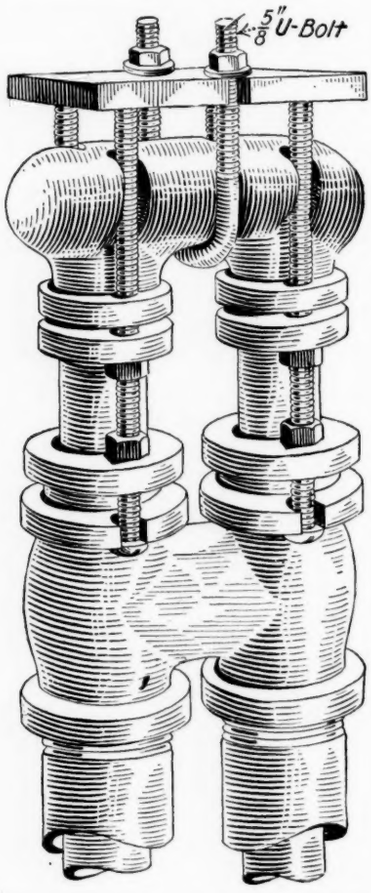
one-half the scale rating, as any higher deflection would indicate that the current coils were receiving more current or the potential winding a higher voltage than the instrument was originally designed for, which might possibly result in the instrument becoming overheated.

With the current coils in series and the potential windings in multiple, the operator would obtain full scale deflection and would hesitate to run the needle off the scale, as he would surely know he was overloading the instrument. HAROLD C. YEATON.

Lynn, Mass.

Opening Ammonia Condensers

Removing the caps from the inclosed tubes of a double-coil ammonia condenser may be easily and safely accomplished with a home-made device such as that illustrated. A plate ½ in. thick is cut out as shown to about 4½x6



CLAMP TO OPEN JOINT ON DOUBLE PIPE CONDENSER

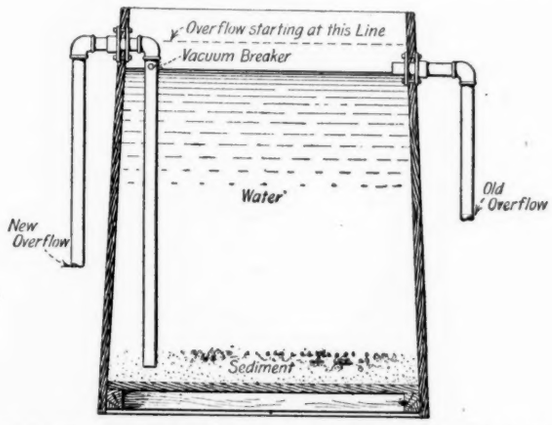
in., with slots to receive the ends of the U-bolt, which is placed under the cap and the nuts tightened on the plate to give a pull on the cap. The nature of the operation is clearly shown in the illustration. A given number of caps can be removed in about one-fourth the time required by the use of a hammer and chisel, and the gaskets are seldom spoiled. JAMES D. ZITO.

Lodi, N. J.

Copper Appears To Have Been the First Metal Used by Man both in war and peaceful acts, as shown by the collections of weapons and other objects of copper and bronze in museums. The ancients obtained most of their copper from Cyprus, hence by corruption the name copper.

Removing Sediment from Tank

An easy way to clean dirt out of a tank when there is water overflowing is shown in the illustration. Usually the overflow pipe is connected to the side of the tank at the top and it skims the water, but the sediment that settles on the tank's bottom is not removed. By extending the pipe



OVERFLOW PIPE EXTENDED TO BOTTOM OF TANK

inside of the tank to the bottom, as shown, and drilling a hole in it at the proper level, any desired amount of water can be discharged and it will carry a large quantity of dirt from the bottom of the tank. The hole should be located at the water line that it is wished to carry, otherwise the tank will be emptied, because the pipe forms a siphon. J. A. SUESS.

Natchez, Miss.

What Is a Stoker?

The "Century Dictionary" defines the words stoke and stoker as follows:

Stoke. To poke, stir up and maintain the fire in a furnace; to supply with fuel; to trim and maintain combustion in a furnace.

Stoker. An automatic device for feeding fuel to a furnace and for keeping the grate free from ashes and clinker.

In view of this authoritative definition, the usage of the words mechanical stoker or the word stoker carries with it the meaning that the apparatus so named is a mechanical means for feeding fuel to a furnace and for the burning of it after it is delivered to the furnace. Therefore it appears proper that only such apparatus for the handling of fuel for combustion as performs these two functions can properly be called a stoker.

However, many manufacturers of devices that only feed the fuel to the furnace, after which it is burned on ordinary grates, and other apparatus necessitating the feeding of fuel to the furnace by hand and the burning of it on stationary, dumping or shaking grates have commenced the practice of calling their devices stokers or mechanical stokers.

The generally accepted meaning of the word stoker is very close to the defined meaning as stated, which is that type of machine that obtains its fuel supply from a hopper, feeds it to a furnace and burns it.

Such being the case, it seems a distinct injustice to those manufacturers of apparatus that are mechanical stokers, for those manufacturers of devices that do not embody the complete requirements of this class of de-

vice to name their products stokers or mechanical stokers.

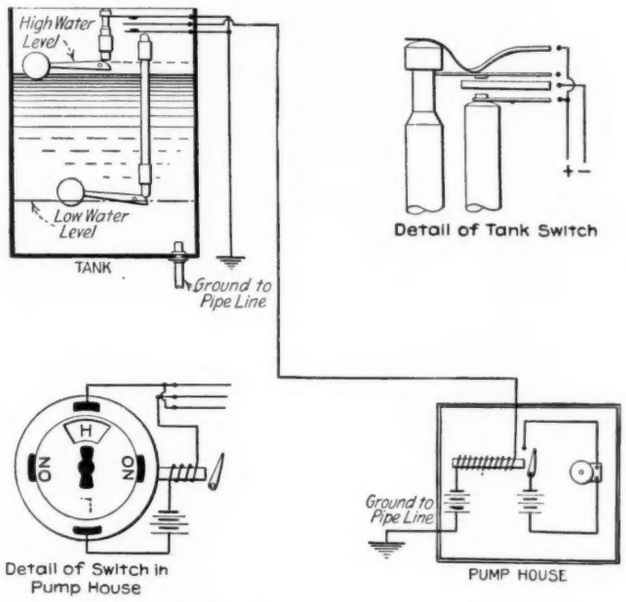
If usage, design, performance and practice give to a machine a designating name, is it not as much of an infringement for machines that do not embody the same elementary principles to use that name as if one infringes others' patents or copyrights?

W. J. KENNEY, President,
Chicago, Ill. Moloch Stoker Co.

Electric Water-Tank Telltale

Some means of indicating the water level in a tank should be provided, and when the pump and tank are at some distance from or out of sight of each other, a visible signal is inconvenient or out of the question.

I have devised a handy arrangement in the form of an electrical alarm, which is operated by the combined action of two floats and a relay. One float makes a contact and rings the bell for high water and the other for low water. The relay battery and contacts are in one circuit,



ARRANGEMENT OF FLOATS AND ELECTRIC CONNECTIONS

which uses the pipe line as a ground return, thus requiring but one wire between the pumphouse and the tank. The relay is used because it can be made of such resistance as to be operated with but a slight current. This relay closes a local bell and battery circuit of low resistance. One battery can be used for both circuits.

The float switch or contacts are made of spring brass, and are insulated from each other. The heavy spring on top of the plunger can be used to help in pressing the contacts together. The rods can be made any size easily operated by the floats. The rods operate through screw-eyes fastened to the side of the tank. The contacts should be made at any water level. A switch is located near the bell or other available place for switching off the alarm, but it should not be left open longer than is necessary. There is but one bell for both the high- and low-water alarm, and the only way of telling which the bell rings for at any given time is by knowing how long the water lasts and when it was last pumped up.

An indicating snap-switch such as is commonly used could be so marked as to indicate whether the switch was last turned off for high or low water.

Ames, Iowa. W. W. PARKER.

Effects of Changing Frequency on an Induction Motor

I would like the privilege of supplementing the answer to M. A. L.'s inquiry, "Change of Frequency on Induction Motor," in "Inquiries of General Interest," Nov. 14, 1916. The matter of voltage is to be considered, and in reality it changes in the same ratio as the change in frequency. A 100-volt 25-cycle motor should work at $\frac{60}{25} \times 100$, or 240 volts on a 60-cycle circuit, and if its speed was 750 r.p.m. on 25 cycles, the new speed would be 1,800 r.p.m. and the capacity $\frac{60}{25}$ of its former rating. The only question is whether the insulation would be sufficient and the mechanical strength of the rotor would stand this increased speed. I am now operating with perfect satisfaction a 6-hp. 40-cycle 550-volt motor on 60 cycles at 825 volts and am getting about 10 hp. out of it. F. E. BRODIE.

Leesville, S. C.

[It is to be agreed that the voltage on an induction motor should be varied directly as the frequency, but unfortunately this is not often convenient without the installation of special transformers. Transformers will cost almost as much as the motor, not considering the additional maintenance charges and losses, consequently if such is Mr. Brodie's case, it would be more economical to buy a new motor or rewind the old one.—Editor.]

Centrifugal Boiler-Feed Pumps

In criticizing the article on "Centrifugal Boiler-Feed Pumps," which appeared in the issue of Oct. 31, page 609, Mr. Schultz states (Dec. 26, page 893) that the maximum pressure of a boiler-feed pump at full speed should not be more than 20 per cent. above the working pressure. This agrees with our statement that the head-capacity curve should be flat. The statement regarding the value of the exhaust of steam-turbine driven pumps supports our contention that this type is the best all-around machine for boiler feeding.

We do not agree that speeds in excess of 3,000 r.p.m. should not be used. One firm having a reputation for turning out work of the highest character runs its standard feed pump, of 120 gal. per min. capacity, at 6,700 r.p.m. and obtains 225 lb. pressure in a single stage.

Regarding the efficiency of pumps of the circular-casing type with or without diffusion rings, the superiority of the former over the latter is considered well established and our discussion pertained to pumps of that type (not the volute type) and to capacities ranging from 80 to 1,200 gal. per min. To cite the performance of a 5000-gal. per min. machine is not a fair comparison, and it would have been more interesting if the characteristic curves of a three- or four-stage pump of the circular-casing type without diffusion rings, handling 500 gal. per min. with 275 ft. head per stage, had been shown instead of a 5000-gal. per min. machine. The efficiency of a 500-gal. per min. machine of this type is about 55 per cent.

The angle of the diffusion vane is not of such importance as Mr. Schultz seems to think. The area and shape of the diffuser have a much greater bearing on the efficiency, and a flat efficiency curve can also be obtained with diffusion-ring pumps.

Regarding the making of tests, we know that out of several hundred steam-turbine driven boiler feeders sent out, not more than five were given a test that could be considered fairly accurate after installation.

The usual construction in this country is the plain ring, and as far as we know, the screwed ring is used by only one of the larger pump manufacturers, all others using plain rings shrunk or forced on. As stated in our article, labyrinth rings work satisfactorily if given sufficient clearance, but the ⊥-section rings work with less clearance and they rotate with the impeller and cannot wear in case the pump is run dry. It appears that Mr. Schultz did not quite "get" the construction of these rings.

In modern double-suction turbine pumps the two sides of each impeller are balanced by means of a balancing port in the diffusion ring, so that the end thrust becomes very small.

The case cited by Mr. Schultz, where two double-suction pumps had to be scrapped on account of excessive end-thrust, does not speak well for the designer of these machines. The fact remains that for larger capacities, double-suction steam-turbine driven boiler-feed pumps give better over-all efficiency than single-suction pumps, as higher speed can be employed and the use of reduction gearing can sometimes be avoided.

Hazleton, Penn. OTTO HAENTJENS.

Referring to the discussion by H. A. Schultz, in the issue of Dec. 26, of the article on "Centrifugal Boiler-Feed Pumps," it is evident that his experience, while "extending over many years," is not complete on some points, for the statements in the original article regarding pump characteristics, comparative advisability of turbine-driven and electric-driven pumps, the use of single-stage pumps and the use of diffusion veins are all in line with present-day practice.

While Mr. Schultz is able to see the fault of the wearing rings, he is eliminating the fault of his own favorite type, the labyrinth rings, in his criticism. The leakage due to labyrinth rings is always large, and it is therefore difficult to maintain pumps using labyrinth rings at high efficiency when the pressure per stage is considerable. The practice of screwing wearing rings on is questionable, to say the least. The statements regarding facilities to permit making a test after installation are perhaps too hopeful.

The single-suction is probably superior to the double-suction pump, but either type should be carefully balanced. E. E. MAHER.

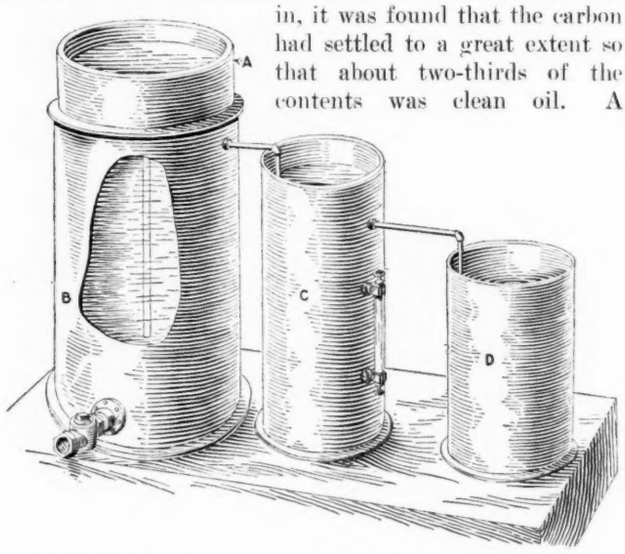
Chicago, Ill.

Pennsylvania Anthracite from Culm Banks has been pulverized and used successfully in the locomotives of the Delaware & Hudson company. This anthracite contained 0.5 per cent. moisture, 8.3 per cent. volatile matter, 72.1 per cent. fixed carbon and 16.5 per cent. ash. These are averages only, the ash in some cases reaching 22 per cent. From 98.7 to 100 per cent. of the powdered fuel went through a 100-mesh screen and from 75.3 to 92.4 per cent. went through a 200-mesh screen. This fuel was used in regular service.—International Railway Fuel Association.

Handling Used Lubricating Oil

In a crude-oil engine plant considerable trouble was experienced in properly filtering the lubricating oil for re-use. The extreme fineness of the carbon carried by this oil made its removal impossible with the filter that had been purchased for that purpose, as it would pass through several thicknesses of woolen cloth to such an extent that the oil looked like black paint, and it would so foul the filter as to require frequent cleanings.

To throw away such quantities of lubricating oil seemed a needless waste, so the engineer as a temporary relief began putting it into some empty barrels. During the first season's operation several barrels were thus accumulated and set away in a storage room until the next season. When one of the barrel heads was knocked in, it was found that the carbon had settled to a great extent so that about two-thirds of the contents was clean oil. A small pump was used to remove the clean oil, and the residue was all dumped together for still further gravity separation. This gave the clue to a satisfactory filtering system. A 100-gallon tank *B* was built with a pan *A* fitted to the top and holding about 10 gallons of oil. From the bottom of this pan a ¼-in. pipe led to a point near the bottom of the tank, and a pipe was connected near the top of the tank so that when almost full the oil would flow into the second unit of the filtering system.



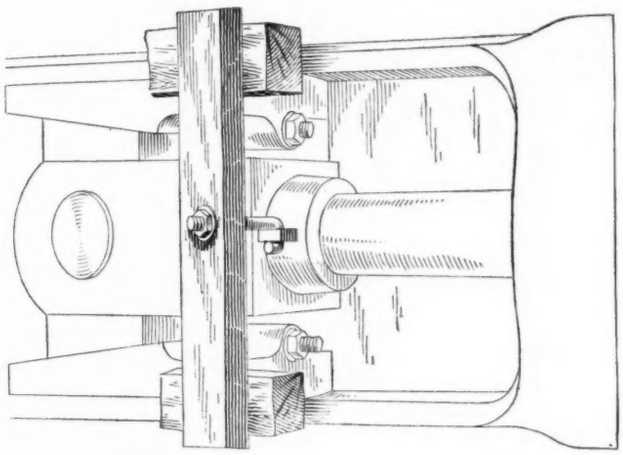
TANKS AND FILTER IN SERIES TO RECLAIM USED OIL

The length of time required for a given quantity of oil to pass through this separating tank, aided by the arrangement of oil flow, allowed the force of gravity to effect a complete separation of oil and carbon. A trial proved that the oil came out in a condition that would have permitted its use without further purification, but as a still further safeguard the original oil filter *C* was placed in position (referred to as the second unit) to receive the clean oil from the separating tank while another tank *D* (the third unit) of about 50 gal. capacity was used as a clean-oil storage, thus permitting the continuous operation of the first two units at fixed levels. All dirty oil is dumped into the pan above the separating tank, into which it flows through the ¼-in. pipe, causing an equal amount of clean oil to flow from the top of this tank into the second unit and on through into the third unit, or storage tank. AMON J. FORTNER.

Pomona, Calif.

Drawing a Tight Key

We found that the key used to fasten the piston rod into the crosshead of an 18x32-in. hoisting engine was so tight that it would be difficult to remove it in our



HOOK BOLT PULLING ON A TIGHT KEY

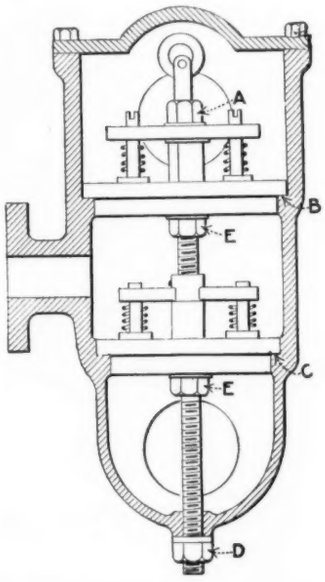
limited time. A ratchet was secured and a ⅞-in. hole drilled in the key; a ¾-in. bolt was heated, bent and extended through a piece of 2-in. square iron blocked in the position shown in the illustration. After drawing up very tight on the nut, a light tap with a hammer loosened the key.

JACK L. BALL.

Amsterdam, Ohio.

A Pump Pointer To Watch Out For

After completely overhauling the water end of a Blake boiler feed pump, it would not work right. It acted just as though it was not getting enough water or had some



PUMP VALVES AND SEATS IN PLACE

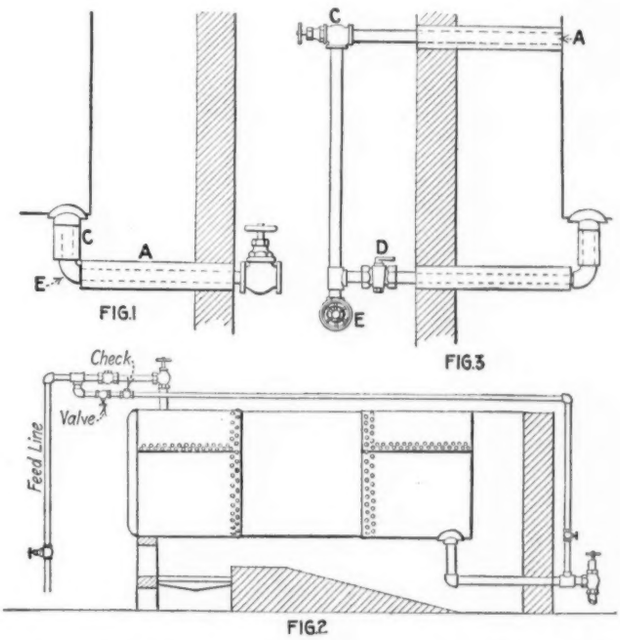
broken valves, but I did not think this could be, for they had all been examined. My next thought was that the valve plates were not pulled down properly on their seats, and this proved to be the trouble. The design of the valve chest is shown, and by removing the nut on the lower end of the kingbolt at *D*, the complete set of suction and discharge valves can be lifted out; after overhauling, they are replaced the same way (all together), but the top nut *A* must be slacked before tightening the bottom nut *D*, in order to bring each valve plate down tight on its seat. If this is not done, one of the seats (at *B* or *C*) may leak and give the same action as a broken or leaky valve. This is what had not been done when the pump was overhauled, but afterward it worked fine.

H. C. WILLIAMS.

Concord, N. H.

Blowoff Failure and Remedy

The blowoff valves on a battery of boilers were originally arranged as shown in Fig. 1, the part of the 2½-in. blowoff pipe in the combustion chamber being protected by a long sleeve *A* extending through the back wall, and the vertical sleeve *C* and the elbow *E* being covered



FIGS. 1 TO 3. PROTECTION FOR BLOWOFF PIPE

Fig. 1—Original piping. Fig. 2—Circulating pipe connected. Fig. 3—Another plan

with magnesia mixed with high-temperature cement 2 in. thick.

Although the boilers were worked above rating, no trouble was experienced until underfeed stokers were installed. After the first had been in operation a month, the blowoff pipe was burned and ruptured inside the setting. This was replaced, using extra-heavy pipe and fittings. In a short time after the second stoker was in operation, the blowoff pipe on that boiler failed as had the first. The engineer decided that the intense heat in the combustion chamber evaporated the water in the pipe so fast that none remained to protect the pipe and accordingly changed them all by placing a tee in the feed line to each boiler and extending a small pipe to the blowoff, as shown in Fig. 2. This causes a circulation through the blowoff pipe, and in three years no further trouble has developed.

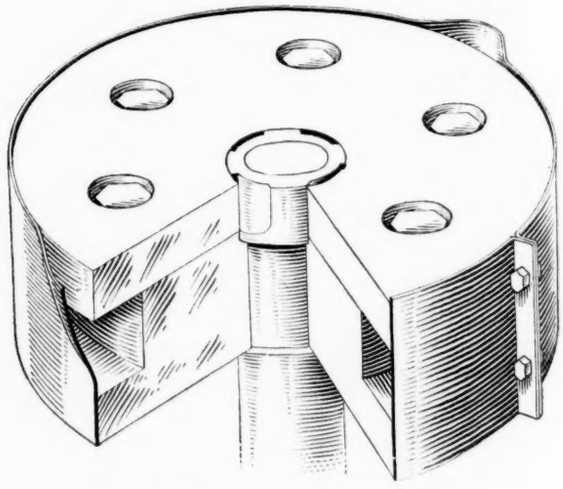
Fig. 3 shows another way to keep the blowoff pipe clear that gives good results. The pipe *A* is tapped into

the back head at the water line and is protected in the combustion chamber by a sleeve and connects into the blowoff pipe outside of the setting, as shown. When the boiler is to be blown down, valve *C* is closed and *D* and *E* are opened. When desirable to flush the pipe *A* or use it as a surface blowoff, *D* is closed and *C* and *E* are opened. Under operating conditions valves *C* and *D* are open and *E* closed. P. E. MERRIAM.

Methuen, Mass.

Emergency Piston Packing Ring

The combined air and circulating pump of one of our condensers was "operating on one leg." A clicking noise came from the steam cylinder (a peak load comes on the plant at 6 p.m.), and it was at noon that we decided to investigate, thinking that it was only a loose follower or broken spring, easily remedied. But when we opened the cylinder, the ring was found broken into four pieces, and we had no spare on hand. I decided to make a ring out of babbitt metal. The piston and its follower were removed from the cylinder and, after cleaning, were re-assembled. A strip of tin was formed into a band to fit over the outside with two lips on the top edge of the band, as shown in the illustration. Old metallic packing and babbitt metal mixed were melted and poured into the piston inside of the tin band. After it was cold, the tin band was cut off, the follower removed and



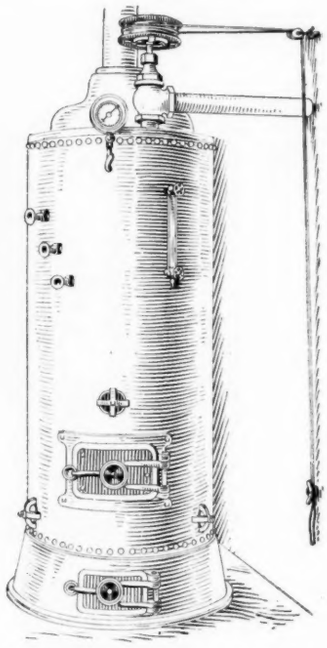
SPACE POURED FULL OF METAL

the babbitt ring dressed up with a file and scraper. A little peening with a hammer made it a fairly good fit to the cylinder, and since 40 lb. of steam is about all the pressure used in this cylinder, its temperature is far below the melting point of babbitt metal. We completed the repair in four hours, and the ring is still doing duty. A new cast-iron ring has been made, but we are waiting for signs of trouble before installing it.

Concord, N. H. H. C. WILLIAMS.

Operating "Out of Reach" Valves

The illustration shows a home-made device for operating a valve that happens to be out of handy reach. An angle valve is mounted on the top of the boiler, as shown, and as the roof of the boiler room gives only a few inches of clearance above the valve, it is inconvenient to reach the handwheel. A wooden drum was turned to a diameter considerably greater than that of the valve wheel, with a recess in the center for the nut on the valve stem, so the drum sets on the rim of the wheel. Four iron clamps were bent, two to fit over the rim and two over the spokes of the wheel. These were held by large wood screws. A cord was wrapped twice around the drum and then carried through a pair of small pulleys



CONTROL VALVE OUT OF EASY REACH

fastened to the wall, level with the drum, and made fast to a cleat. It is necessary to keep the cord taut while working the valve, in order to get a grip on the drum and to keep it from running off. Of course this is nothing new, but it works first-rate. HUGH G. BOUTELL.

Philadelphia, Penn.

Removing Pipe Fittings

Iron fittings on pipe can be easily loosened and taken off by first heating to a dull red and then cooling the inner part with water, leaving the outer part as hot as possible while unscrewing. Fittings that cannot be started otherwise can frequently be removed in this way with very little effort.

Incidentally the foregoing is a good way to spoil pipe wrenches. If possible, the fittings should be clamped in a vise and the wrench applied to the part cooled only, as the hot iron will draw the temper from the teeth of the wrench and cause them to dull quickly.

Brass fittings can be loosened in the same way, but care must be taken not to get them too hot. As the coefficient of expansion of brass is greater than that of iron, if the brass part is the outer part, it will be loosened before it is heated enough to injure it.

Valuable fittings are sometimes ruined by careless handling in removing from piping. Valves and fittings are frequently clamped in a vise and crushed out of shape —spoiled by brute force. G. E. MILES.

Green River, Wyo.

Simple Alloy Steel is alloy steel containing one alloying element, as, for example, simple nickel steel.

Inquiries of General Interest

Power Required To Raise a Load—A grade 1 mile long has a vertical rise of 100 ft. Assuming that 5 per cent. of the power is lost in friction, what horsepower would be required to haul a load of 100,000 lb. up the grade in 10 min.? M. D. H.

To raise the load without friction through a vertical height of 100 ft. in 10 min. would require the expenditure of (100,000 × 100) ÷ 10 = 1,000,000 ft.-lb. of energy per minute, or 1,000,000 ÷ 33,000 = 30.30 hp., regardless of the length of the inclined plane or the character of mechanical elements that might be employed for the purpose. If 5 per cent. of the power is lost in friction, the actual power required would be 30.30 ÷ (1 — 0.05) = 31.89 hp.

Required Pitch of Screw—What must be the pitch or lead of a jackscrew to raise a weight of 40,000 lb. with a force, or pressure, of 200 lb. acting with a leverage of 5 ft.? F. B. P.

In one revolution the space passed through by the force at the end of the lever would be 2π × 5 ft., or 2 × 3.1416 × 5 = 31.416 ft., and the energy exerted would be 31.416 × 200 = 6283.2 ft.-lb. Allowing one-third loss from friction, the net work performed in one revolution would be two-thirds of 6283.2, or 4188.8 ft.-lb. Therefore the pitch of the screw, or distance the weight could be raised for one revolution, would be 4188.8 ft.-lb. ÷ 40,000 lb. = 0.10472 ft., or 0.10472 × 12 = about 1¼ in.

Load on a Three-Wire System—If the ammeters in the positive and negative legs of a 120-240-volt three-wire system read 400 and 350 amp. respectively, the voltage from positive to neutral is 116 and from neutral to negative 118, what is the total load in kilowatts? R. G. A.

The load on an Edison three-wire system is equal to the sum of the volts times the amperes on each side of the system divided by 1000. In this case $\frac{(116 \times 400) + (118 \times 350)}{1000} = 87.7$ kw. If the voltage is balanced, the sum of the two ammeter readings times the voltage on one side of the line will give the correct result.

To Determine Whether Pipe Is Wrought Iron or Steel—What is an easy method of testing whether pipe is made of wrought iron or steel? C. M.

Cut off a short piece of the pipe and file or grind one end smooth. Then suspend the sample in a solution of 1 part muriatic acid, 3 parts sulphuric acid and 9 parts water in a porcelain or glass dish, in such a manner that the prepared end will not touch the bottom of the dish. After about three hours' immersion, remove the sample, wash off the acid and observe the etching effect. If the pipe material is steel, the prepared end will present a bright unbroken surface; if iron, it will show concentric ridges or rings consisting of layers of iron and streaks of cinder.

Relative Conductivity of Soot and Scale—Are any reliable data available as to the relative transmission of heat through equal thicknesses of soot and scale on boiler tubes? F. C. R.

It has been demonstrated that general conclusions as to the relative heat conductivity of different thicknesses of boiler scale and also of soot based on individual tests are purely speculative. In either case the rate of transmission of heat depends on the composition and density of the material. In an accumulation of soot or of scale these properties vary in different layers of which the thickness of the material is composed according to chance conditions. It therefore becomes impractical to rely on comparison of results obtained in different cases or of different materials.

Boiling of the Water in a Vertical Boiler—At what level does boiling take place in a vertical cast-iron boiler of the type used for house heating? J. W. H.

Boiling is the disturbance of the water due to the ascent of volumes of gas or vapor that are liberated from a liquid at any point where the temperature is high enough to form a gas or vapor of sufficient tension to overcome the pressure at that point. In an internally fired vertical boiler the heating surface of the water-legs is far less efficient, and consequently there is slower vaporization in the lower part of the boiler than in the upper part, where the heating surfaces are exposed to products of combustion of higher temperature. But under ordinary operation some vaporization and boiling takes place at all levels of the water contained in the boiler.

Blowoff Pressure of Lever-Safety Valve—The area of a lever-safety valve of a boiler is 12 sq.in., and the weight of the valve and valve stem is 10 lb. The distance from the fulcrum to the point of attachment of the valve stem to the lever is 4 in.; weight of the lever, 15 lb.; distance from the fulcrum to the center of gravity of the lever, 20 in.; weight of the ball, 75 lb. With the ball hung on the lever 35 in. from the fulcrum, at what pressure will the safety valve blow off? H D.

The pressure on the valve stem from the weight of the lever would be 15 × (20 ÷ 4) = 75 lb., and from the ball would be 75 × (35 ÷ 4) = 656.25 lb. As the weight of the valve itself is 10 lb., the valve would exert a total downward pressure of 75 + 656.25 + 10 = 741.25 lb., and as the valve area presented to the steam pressure is 12 sq.in., it would be raised for any pressure greater than 741.25 ÷ 12 = 61.77 lb. per sq.in.; that is, the blowoff pressure would be practically 62 lb. per sq.in.

Approximate Rule for Estimating Power of Engine—What is a short or approximate rule for estimating the power of an engine? L. R.

The actual power developed as given by the formula,

$$\text{I.hp.} = \frac{P \times L \times A \times N}{33{,}000}$$

is equivalent to

$$\text{Hp.} = \frac{\text{Piston speed per min.} \times \text{m.e.p.} \times \text{area of piston}}{33{,}000}$$

Calling d = diameter of piston in inches, the area of piston in sq.in. = $d^2 \times 0.7854$, and assuming a piston speed of 600 ft. per min. the formula becomes

$$\text{I.hp.} = \frac{600 \times d^2 \times 0.7854 \times \text{m.e.p.}}{33{,}000}, \text{ or } \frac{1}{70} \times d^2 \times \text{m.e.p.}$$

If the m.e.p. is assumed to be 35 lb., which is a fair average in practice, the formula becomes

$$\text{I.hp.} = \frac{35}{70} d^2, \text{ or } \tfrac{1}{2} d^2.$$

Hence by assuming a piston speed of 600 ft. per min. and a mean effective pressure of 35 lb. per sq.in., a short rule for estimating the indicated horsepower of an engine is: Square the diameter of the cylinder in inches and divide by 2.

Boiler Efficiencies Under Different Conditions—Where a boiler evaporates 8.8 lb. of water per pound of coal from a feed-water temperature of 190 deg. F. into steam at 135 lb. gage, using coal containing 13,450 B.t.u. per pound, what would be the increase in the percentage of efficiency if the evaporation is 8.75 lb. of water from a feed-water temperature of 192 deg. F. into steam at 134 lb. gage using coal containing 13,050 B.t.u. per pound? P. E. M.

A pound of steam at 135 lb. gage, or 150 lb. absolute, contains 1193.4 B.t.u. above 32 deg. F., and with the feed water at 190 deg. F., or 158 deg. F. above 32 deg. F, each pound of feed water evaporated into steam would receive 1193.4 — 158 = 1035.4 B.t.u.; where the evaporation is 8.8 lb. of water per pound of coal, the heat realized would be 9111.52 B.t.u. per lb. of coal, and with coal containing 13,450 Bt.u. per lb., there would be 9111.52 ÷ 13,450 = 0.6774, or 67.74 per cent. efficiency. Where the steam pressure is 134 lb. gage, or 149 absolute, a pound of the steam would contain 1193.3 B.t.u. above 32 deg. F., and with the temperature of the feed water 192 deg. F., or 160 deg. F. above 32 deg. F., each pound of feed water evaporated into steam would receive 1193.3 — 160 = 1033.3 B.t.u.; and with an evaporation of 8.75 lb of water per pound of coal the heat realized would be 1033.3 × 8.75 = 9041.38 B.t.u. per pound of coal; and with coal containing 13,050 B.t.u. per pound there would be 9041.38 ÷ 13,050 = 0.6928, or 69.28 per cent efficiency, and there would be 69.28 — 67.74 = 1.54 per cent. gain of efficiency.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

California Air Tank Orders

SYNOPSIS—These orders are issued by the Industrial Accident Commission of California and are here printed in full. Some of the orders apply to the air compressor and its discharge pipe.

The following safety orders are being issued by the Industrial Accident Commission of California:

Order 900: (a) Whoever owns, uses or causes to be used any air-pressure tank which carries 25 lb. or over pressure per square inch shall report the location of the same to the Industrial Accident Commission within 90 days after these orders become effective, except as exempted in Order 902 (b).

Order 901: (a) No person shall install or use or cause to be used any air-pressure tank with a pressure exceeding 25 lb. per sq.in., unless the owner or user thereof shall hold a certificate of inspection issued by the Industrial Accident Commission or by an inspector of boilers holding a certificate of competency or a deputy inspector's permit from the Industrial Accident Commission of the State of California.

Order 902: (a) Every air-pressure tank carrying 25 lb. or over pressure per square inch shall be inspected internally and externally not less than once every two years. A certificate of inspection shall be issued on the form prescribed by the Industrial Accident Commission if said tank be found to conform to these orders.

(b) The following air-pressure tanks are exempted from inspection:

1. Air-pressure tanks under the jurisdiction of the Federal Government.
2. Air-pressure tanks on street or railroad cars, motor vehicles, locomotives and cars under the jurisdiction of the Interstate Commerce Commission.
3. Air-pressure tanks used exclusively for agricultural purposes.

Order 903: (a) A copy of all inspection reports shall be forwarded to the Industrial Accident Commission within 21 days after the inspection has been made, on forms provided. Such reports shall set forth any changes or additions necessary for the issuance of a certificate of inspection.

(b) Insurance companies whose inspectors hold certificates of competency as boiler inspectors or who hold deputy inspector's permits shall report to the Industrial Accident Commission the name of the owner or operator and location of every air-pressure tank on which insurance has been refused, canceled or discontinued, giving the reasons therefor.

(c) Upon request of the Industrial Accident Commission or of an inspector of boilers holding a certificate of competency or a deputy inspector's permit from the Industrial Accident Commission, the owner or operator of any air-pressure tank operated at over 25 lb. pressure shall prepare the said tank for inspection. The application of a hydrostatic-pressure test shall lie in the discretion of the inspector, and if so ordered, the owner or user shall make the necessary preparations for such test by blanking off connections and filling said tank with water.

(d) In no case shall a hydrostatic test exceed 1½ times the maximum safe working pressure.

Order 904: (a) The safe working pressure on an air-pressure tank shall be determined by the rules laid down in paragraph 378 of the American Society of Mechanical Engineers Boiler Code.

(b) The lowest factor of safety used shall be 5 for air-pressure tanks not over 10 years old, which are constructed of plates less than ¼ in. in thickness. For each five years thereafter, the factor of safety shall be increased by one-half point.

(c) Factors of safety for shell plates of ¼ in. or over shall be:

4 for tanks not over 5 yr. old;
4½ for tanks over 5 and not over 10 yr. old;
4½ for tanks over 10 and not over 15 yr. old;
5 for tanks over 15 and not over 20 yr. old.

For each five years thereafter the factor of safety shall be increased by a further one-half point.

(d) In case of unknown age of an air-pressure tank, the minimum factor of safety shall be 5.

(e) The ultimate tensile strength of a longitudinal joint which has been properly welded shall be taken as 28,500 lb. per sq.in.

(f) Air-pressure tanks with brazed joints will not be allowed.

(g) When old boilers or old boiler drums are used as air-pressure tanks, the following rules shall be used in computing the safe working pressure on stayed or unstayed heads:

1. For unstayed flat heads of tanks over 20 in. diameter:

$$\text{Safe working pressure} = \frac{t \times ts \times 10}{a \times 8}$$ (which is a factor of safety)

Where t = Thickness of head in inches;
ts = Tensile strength of material in lb. per sq.in.;
10 = A constant;
a = Area of head to be stayed, in square inches.

2. For unstayed flat heads of tanks 20 in. or less in diameter:

$$\text{Safe working pressure} = \frac{ct^2}{a}$$

Where c = 112 for heads less than $\frac{7}{16}$ in. thick;
c = 120 for heads over $\frac{7}{16}$ in. thick;
t = Thickness of head in sixteenths of an inch;
a = ⅓ area of head in square inches.

3. For bumped heads concave to pressure:

$$\text{Safe working pressure} = \frac{t \times ts}{r \times 5}$$ (which is a factor of safety)

Where t = Thickness of head in inches;
ts = Tensile strength of material;
r = ⅔ radius to which the head is bumped, in inches.

4. For bumped heads convex to pressure:

$$\text{Safe working pressure} = \frac{t \times ts \times 0.6}{r \times 5}$$ (which is a factor of safety)

Where t = Thickness of head in inches;
ts = Tensile strength of material;
r = ⅔ radius to which the head is bumped, in inches.

5. For stays on flat heads the maximum allowable stress per square inch of net cross-sectional area shall not exceed the values given in the following table:

Material and Type	Size up to and Including 1¼ In. Diameter or Equivalent Area, Lb.	Size Over 1¼ In. Diameter or Equivalent Area, Lb.
Weldless mild steel head to head or through stays	8,000	9,000
Weldless mild steel diagonal or crow-foot stays	7,500	8,000
Weldless wrought iron head to head or through stays	7,000	7,500
Weldless wrought iron diagonal or crow-foot stays	6,500	7,000
Welded mild steel or wrought iron stays	6,000	6,000
Mild steel or wrought iron stay-bolts	6,500	7,000

Order 905: (a) Every air-compressor system shall have one or more safety valves of the direct spring-loaded type installed on the delivery line.

(b) No safety valve shall exceed 3-in. diameter.

(c) Safety valves having either the seat or disk of cast iron shall not be used.

(d) Each safety valve shall have a direct connection to the air-compressor system, of a size not less than that of the safety valve.

(e) When an escape pipe is used, it shall have a cross-sectional area not less than that of the safety valve and be provided with an open drain.

(f) When two or more safety valves are placed on one connection, this connection shall have a cross-sectional area equal to or greater than the combined areas of all the safety valves.

(g) There shall be no valve of any description placed between the safety valve and the compressor, or the escape pipe that would prevent the operation of the safety valve.

(h) The safety-valve capacity for each air compressor shall be such that the safety valve will discharge all the air that can be delivered by the air compressor.

Order 906: (a) There shall be a drain fitted with valve or cock in direct connection with the lowest portion of each air-pressure tank.

(b) All air-pressure tanks while in service shall be thoroughly drained of all accumulations of oil and water at least once in every working day. (This does not apply to hydropneumatic pressure tanks, elevator pressure tanks or pressure tanks of automatic sprinkler systems.)

(c) Every air-compressor system shall have at least one pressure gage attached to the receiver, graduated to not less than 1½ times the maximum pressure allowed on the system and so located as to be easily read from the floor.

1. Each gage shall be fitted with a cock only, having a T or lever handle so set as to indicate whether the cock be open or closed.
2. Each air-compressor system shall be provided with a ¼-in. valve for attaching a test gage.

Order 907: (a) The specifications and regulations relating to the material and construction of new boilers as contained in Part I, Sec. 1, of the A. S. M. E. Boiler Code shall govern the construction of air-pressure tanks over 24-in. diameter which are built after these orders become effective, with these exceptions:

1. A sworn statement of the manufacturer that the air-pressure tank has been constructed according to the Boiler Code Orders will be accepted in lieu of the Boiler Code Stamp, provided the said air pressure tank be stamped as provided in Section b, preferably near the inspection

opening; said letters and numbers to be not less than ¼ in. in height.

2. Paragraphs 187 and 188, page 45, of the A. S. M. E. Boiler Code shall not apply to these orders.
3. No longitudinal seams of single-riveted lap construction will be permitted on air-pressure tanks of over 36-in. diameter, which carry pressures exceeding 50 lb. per sq.in.
4. An air-pressure tank on which a lap-seam longitudinal joint is permitted shall not have a course over 12 ft. in length.

(b) All air-pressure tanks built after these orders become effective shall be stamped with the manufacturer's name or trade mark and date of manufacture, the form of stamping to be registered with the Industrial Accident Commission.

(c) The minimum thickness of shell plates used in the construction of air-pressure tanks 24 in. or less in diameter shall be as follows:

12 to 16 in. inclusive	11-gage U. S. Standard
Over 16 to 20 in. inclusive	8-gage U. S. Standard
Over 20 to 24 in. inclusive	7-gage U. S. Standard

(d) Standard or extra-heavy wrought pipe, or deep-well casing not less than ¼ in. thick may be used, provided the end fittings used as heads also meet the requirements of the manufacturers' standards for pressures carried not to exceed 200 lb. per sq.in.

(e) Shells of cast iron shall not be used.

Order 908: (a) Up to and including 18-in. diameter, air-pressure tanks may be internally inspected through the pipe-fitting openings, provided that where heads are removable at least one head shall be taken off.

(b) Air-pressure tanks over 18 in. and up to and including 36-in. diameter, except where such air-pressure tanks are provided with handholes or manholes, shall have two flanges for not less than a 3-in. standard pipe. These flanges may be located either in shell or heads, but if in the shell, they shall be located as near the heads as practicable. If pipe or drain connection is made to these inspection flanges, a union or a flange joint must be placed as near the inspection flanges as practicable.

(c) A manhole not less than 11 x 15 in. shall be provided in all air-pressure tanks over 36-in. diameter.

(d) Handholes or manholes may be omitted where the heads are removable.

Order 909: (a) All air-pressure tanks shall be so installed that they are easily accessible for inspection.

Order 910: (a) Efficiency of joints, bracing and staying of flat surfaces, paragraphs 410 to 420 inclusive, of the Appendix of the A. S. M. E. Boiler Code are hereby made a part of these orders.

Order 911: (a) Air-pressure tanks in this state on or before the date these orders become effective, which do not conform to the prescribed regulations, may be installed or reinstalled after a thorough internal and external inspection and hydrostatic-pressure test, at the discretion of an inspector of the Industrial Accident Commission, or of a boiler inspector holding a certificate of competency or a deputy boiler inspector's permit issued by the Industrial Accident Commission of the State of California.

Alquist Gearing for Ship Propulsion

At the annual meeting of the Society of Naval Architects and Marine Engineers, W. L. R. Emmet described a new form of gear which has been developed by the General Electric Co. for use in ship propulsion. The design is such as to afford a distribution of strain and means by which excessive strain would not be imposed upon any part through slight imperfections, distortions or inaccuracy. The gear is built up of a number of plates machined to form, which gives them the desired degree of lateral flexibility. These plates are put together, engaging solidly at the hub and also engaging on a narrow edge at the periphery. When so put together, they form a solid cylinder, which can be cut spirally in the ordinary manner. After cutting, the edge engagements are released with a small dividing tool so that each disk operates independently and is free to deflect laterally under the side pressure which results from its diagonal engagement with the pinions. The parts are so proportioned that the lateral deflection can at no time involve fiber strain which could possibly cause destructive fatigue.

Gears of this character have been applied to 72 sets in which steam turbines drive electric generators, and contracts have been closed for machinery aggregating 215,200 hp for the propulsion of 70 ships. Some of these electric generating sets have been in service for a year and a half. Among these are the high-pressure units for the battleship "Nevada," also equipment for a destroyer building at the Mare Island Navy Yard and new propelling machinery for the scout cruiser "Salem."

Gears of the Alquist type are applied in three ways: First, a single reduction has been accomplished by engaging one solid pinion with a flexible gear; second, by engaging a solid pinion with two flexible idlers, which in turn engage with a solid large gear; and third, in a double reduction where a solid high-speed pinion engages flexible gears on two countershafts, these countershafts carrying solid pinions, both of which engage a flexible gear on the same low-speed shaft. In the last two applications the flexibility of the gears serves to equalize the load between all the driving points and the use of a plurality of driving points on the large gear reduces the length of face necessary on that gear.

From experiments made at Schenectady, it would appear that gears are more efficient at low speed than at high speed. Solid gears at low speed involve difficulties because they diminish pinion diameters and increase pinion lengths, whereas the flexibility of the Alquist gear enables one to compensate easily for all possible degrees of torsional yield in the pinion, and with such gears the peripheral speed can safely be reduced by making the gears longer and of smaller diameter.

Petroleum Records Broken in 1916

That 1916 was a record-breaking year for the petroleum industry of the United States is indicated in a preliminary estimate of the crude-oil output just made public by John D. Northrop, of the United States Geological Survey, Washington, D. C. The Survey estimates that during the last year 292,300,000 bbl. of crude petroleum was produced and marketed in the oil fields of this country. This quantity is greater by 11,000,000 bbl., or 4 per cent., than the output in 1915, and in addition to the quantity of oil produced and marketed in 1916, several million barrels was produced and placed in temporary field storage in Kansas and Oklahoma.

Examination of the figures prepared by Mr. Northrop shows that Oklahoma and California led in the production of petroleum in 1916, as they did during the previous year, Oklahoma producing 105,000,000 bbl. during the last year as against 98,000,000 in 1915, and California turning out 89,000,000 bbl. as against 86,500,000 in the previous year. Illinois, Louisiana, West Virginia, Ohio and Colorado all showed a decrease, as compared with 1915, while Kansas showed the greatest percentage of increase, jumping from 2,800,000 bbl. in 1915 to 6,500,000 bbl. in 1916—a gain of about 125 per cent.

The increase in 1916 is accounted for by the continued ability of the newer fields in the Mid-Continent (Kansas) and Rocky Mountain regions to supply enough oil from new wells to more than offset the normal decline in the older fields east of the Mississippi. The incentives that caused the increase in 1916 included higher prices for oil in the wells, which encouraged drilling in all fields; a decrease in production in the Cushing pool, in Oklahoma, which allowed the product of other Mid-Continent fields free access to markets; and a greatly increased demand for crude oil, expressing the needs of a large number of new refineries that were installed during the period of overproduction and low prices in 1914 and 1915. The principal centers of increased production in 1916 were in Estill and Allen Counties, Kentucky; Butler County, Kansas; Carter County, Oklahoma; and Converse, Park and Natrona Counties, Wyoming.

The prices of crude oil at the wells averaged considerably more in 1916 than in the preceding year. The upward tendency of the market, inherited from 1915, persisted, with steady advances in the prices of practically every type of high-grade oil, until March, when relative stability at high levels was attained. During this period Pennsylvania grade advanced from $2.25 a barrel to $2.60, and Oklahoma-Kansas grade from $1.20 to $1.55, while the product of the Cushing pool commanded a premium of from 50 to 60c. above the price last quoted. Except for reductions of little significance in the price of one of the low-grade crude oils produced in northern Louisiana, in June, and in the premiums paid for Cushing oil, these high prices were maintained until the middle of July, when, led by all the northern Louisiana grades on the 15th and followed by the Oklahoma-Kansas grade on the 24th and by Pennsylvania and associated grades on the 29th, a retrogressive movement began which lasted until late in August and reduced the price of Oklahoma-Kansas grade to 90c. per barrel, practically eliminated the Cushing premium and brought Pennsylvania grade to $2.30 a barrel.

This depression in the prices of crude oil was centered in the Mid-Continent fields, where, subsequent to the decline of the Cushing field, general activity in the old pools and in newly discovered extensions had been attended with success

so great as to bring about over-production. The prompt curtailment of production in the more prolific newer fields prevented further reductions in price, and the features of the closing months of the year were an advancing market that affected Pennsylvania grade on Sept. 28 and the Oklahoma-Kansas grade on Nov. 29. The closing prices per barrel for these typical grades were: Pennsylvania, $2.85; Oklahoma-Kansas, $1.40.

As a consequence of an increasing demand for oil and a decrease in the stocks held by pipe-line companies and purchasing agents, states the Survey's report, the market for grades of petroleum produced in California was uniformly strong throughout the year. The quotations posted on Dec. 28, 1915, remained in effect until the middle of the next February, when all grades except Ventura County were advanced 10c. A further advance of 5c., posted Apr. 1, likewise affected all grades except Ventura County. Subsequent advances of 5c. each, involving all grades of oil produced in the state, became effective on Sept. 20 and Nov. 21.

Under the stimulus of relatively high prices for crude petroleum during the spring and early summer of 1916, drilling was active throughout the country, not only in proved areas, but in places far from developed areas of oil and gas. The greatest wildcat activity, according to the figures given by the Survey, was in Kansas, Oklahoma, Texas and Wyoming.

PERSONALS

J. Walter Allen has been appointed electrical engineer of the Boston (Mass.) Elevated Ry.

Joseph H. O'Brien, engineer for Westinghouse Church Kerr & Co. for the last 14 years, has been made vice-president of the General Construction Co., of Harrisburg, Penn.

E. W. Barron, formerly chief engineer of the electric plant at Tallapiedra, Havana, and for the past two years commercial engineer for the Havana Electric Railway, Light and Power Co., has accepted the position of chief engineer at Central Isabel, Guantanamo, Cuba.

G. E. Willard, formerly with the New York Central R.R. at Weehawken, N. J., has been appointed superintendent of the Quakertown municipal electric light department at Quakertown, Penn., succeeding J. B. Taylor, who is now with the Pennsylvania Seaboard Steel Co., at Chester, Penn.

OBITUARY

Henry Gordon Stott

Henry Gordon Stott, superintendent of motive power of the Interborough Rapid Transit Co. and the New York Railways Co., of New York, died at his home in New Rochelle, Jan. 15, after an illness of many months.

He was a native of the Orkney Islands, Scotland, where he was born in 1866, the son of the Rev. David and Elizabeth Jane (Dibblee) Stott. After a thorough grounding in the fundamentals at the hands of his father and elementary school instructors, he was enrolled as a student at the Watson Collegiate School, Edinburgh. On leaving this institution, he entered the College of Arts and Sciences at Glasgow and began a course in mechanical engineering and electricity, graduating in 1885. In the year previous he had entered the employ of the electric illuminating company of Glasgow. Shortly after graduating, he was made assistant electrician on board the steamship "Minia," belonging to the Anglo-American Telegraph Co. The next 4½ years saw him engaged with those duties, during the course of which he saw much service in connection with repairs to the cable lines of that company. In this period he undertook a number of experiments that resulted in the introduction of improved methods of handling cable repairs. He was also identified with the "duplexing" of the United States Cable Co.'s main cable (2750 knots), the longest duplex cable in the world.

In 1889 Mr. Stott was made assistant engineer of the Brush Electric Engineering Co.'s plant at Bournemouth, England. The following year he was offered a post by Hammond & Co. as assistant engineer in the construction of an underground cable and power plant at Madrid, Spain. He remained there until 1891, coming to the United States in that year to install an underground cable and conduit system for the Buffalo Light and Power Co. (now the Buffalo General Electric Co.). This work was completed with a degree of success that reflected very greatly to the credit of Mr. Stott. As a result he was named engineer of the company, and during the next 10 years was one of the most active figures in the industrial progress of Buffalo. During this period he designed and executed some notable construction work, including a power plant on Wilkeson St., Buffalo.

His efforts attracted wide attention, and in 1901 he was appointed superintendent of motive power of the Interborough Rapid Transit Co., New York City, a position which he has filled with signal success. At the time he took up these duties, the Interborough had not yet been organized, the company having the title of the Manhattan Railway Co. The post that Mr. Stott was called to had just been created, and it devolved

HENRY GORDON STOTT

upon him to organize the operating force, in connection with which he completed the Seventy-fourth St. power plant of the company, various substations and transmission lines.

When the Manhattan system was amalgamated with the Interborough in 1904, Mr. Stott was invited to retain his office with the new corporation. He accepted and immediately took over supervision of the construction of the power plant on Fifty-ninth St. Since that time he had been constantly in charge of design, construction and operation of the power-generating stations and the distributing system of the Interborough, which comprehends the subway, elevated and surface lines of New York City.

The plans for the electric-power system of the new subway lines have been developed under his supervision, and the work has progressed so far and bears so strongly the stamp of his work that, when completed, it will be a monument to him.

He was also consulting engineer for the Buffalo General Electric Co. in connection with the construction of the new River Station, where the high pressures and high ratings are characteristic of Mr. Stott's advanced ideas.

Mr. Stott was a firm believer in coöperation among engineers, through the engineering societies. He was elected president of the American Institute of Electrical Engineers for the term 1907-8, vice-president of the American Society of Mechanical Engineers for the term 1912-14, director of the

American Society of Civil Engineers in 1911, and was vice-president and trustee of the United Engineering Societies at the time of his death. Up to the last he was a recognized power in the American Institute of Electrical Engineers and was a member of the Standards Committee, the Public Policy Committee, the Committee on Development of Water Power, the United States National Committee of the International Electrotechnical Commission, the Power Stations Committee, the Committee on Economics of Electric Service, the Edison Medal Committee, and one of the institute's representatives on the Joint Committee on the Metric System, of which he was an ardent advocate.

As a result of his unusually wide experience and extended research, Mr. Stott has often been called upon to contribute papers to the various engineering societies. He is especially well known for his minute analyses of engineering problems. Among the large number of papers which he has written on this subject are: "The Conversion and Distribution of Received Currents," "Power-Plant Economics," "Notes on the Cost of Power," "Steam-Pipe Covering and Its Relation to Station Economy," "Tests of a 15,000-Kilowatt Steam-Engine Turbine Unit," "Power-Plant Design and Operation" (a series), etc.

Mr. Stott was a remarkable figure in the engineering world because he was in the front rank of both electrical and mechanical engineers, because in both branches of the art he was a master of theory and practice, and because with these technical qualifications he combined a rare executive ability, power of inspiring the confidence of his employees and of bringing out the best that was in the men who worked for him.

His activities were not confined to engineering matters. He early became a citizen of the United States and served for five years in the 74th Regiment of the National Guard of New York State. He was also an active member of the Protestant Episcopal Church, being a communicant of St. Paul's Church, of New Rochelle, in the affairs of which he was deeply interested.

He was married July 22, 1894, to Miss Anna Mitchell, of Belfast, Ireland, who with their two children, a son and a daughter, survive him. The family home is at New Rochelle, N. Y.

Funeral services were held at his late residence, Rochelle Heights, New Rochelle, on Wednesday evening, Jan. 17, 1917.

ENGINEERING AFFAIRS

Pittsburgh Section, Association of Iron and Steel Electrical Engineers will hold a meeting under the auspices of the Safety Committee, at the Fort Pitt Hotel, on Saturday, Feb. 17.

Philadelphia Section, Association of Iron and Steel Electrical Engineers, will hold a meeting at the Majestic Hotel, on Saturday, Feb. 3. Subject: "Polyphase Motors," by James Burke, president of the Burke Electric Co., Erie, Penn.

The American Electric Railway Association will hold its seventh annual midyear meeting and dinner at the Copley-Plaza Hotel, Boston, Mass., on Feb. 16. An unusually interesting program has been arranged for the meeting, and speakers of national reputation will talk.

The American Institute of Steam Boiler Inspectors of New York City will hold its regular meeting in the Engineering Societies Building, 29 West 39th St., New York City, on Friday evening, Jan. 26. Election of officers for the ensuing year will take place, after which discussion by the members will be brought up.

The Western Society of Engineers held its annual meeting and dinner on Jan. 10 at the Hotel Sherman, Chicago. B. E. Grant, retiring president, summarized the history of the society since its inception in 1869. A constructive program and a continuance of present activities was pledged by the president-elect, Henry J. Burt. Dean F. E. Turneaure, of Wisconsin University, spoke on the "Engineering School and the Engineering Profession," and James Keeley, editor of the "Herald," gave an interesting talk on "Some Thoughts About After-War Conditions." W. L. Abbott, of the Commonwealth Edison Co., acted as toastmaster. During the evening the Chanute medals, awarded annually for the two best papers of the preceding year, were presented to Curtis McTownsend for a paper on the "Currents of Lake Michigan and Their Effect on the Climate of Adjoining States," and W. M. Wilson for his paper on "Wind Stresses on the Steel Frames of Office Buildings." The following officers for the ensuing year were installed: H. J. Burt, president; D. W. Roper, first vice-president; James N. Hatch, second vice-president; W. W. DeBerard, third vice-president; C. R. Dart, treasurer; O. F. Dalstrom, incoming trustee for three years. After the formal program a number of the members presented a one-act comedy entitled "Why Is a Structure." On the following day a tour of inspection was made by members of the society to the plants of the Pullman Co. and the Illinois Steel Co.

The American Institute of Electrical Engineers will hold its midwinter convention in the Engineering Societies' Building, 33 West 39th St., New York, Feb. 14 to 16, 1917. The registration office will be in the lobby of the Engineering Societies' Building. There will be five technical sessions, one each morning and on Wednesday and Friday afternoons. The convention will open Wednesday morning, Feb. 14, with an address by President H. W. Buck, followed by a paper entitled "Internal Temperatures of A.-C. Generators." At the afternoon session two papers will be presented—one on "Reactors in Hydro-Electric Stations" and the other on "Protection of Transformer Neutrals Against Destructive Transient Disturbances." The evening will be devoted to a social function. On Thursday at the morning session three papers will be presented—"Corona and Rectification in Hydrogen," "The Electric Strength of Air" and "Oscillating Current Circuits by the Method of Generalized Angular Velocities." Thursday afternoon will be devoted to an inspection trip. At the Thursday evening session Prof. R. A. Millikan will lecture on the subject of "Modern Physics." Two papers will be read at the Friday morning session—"Industrial Controllers with Particular Reference to the Control of Direct-Current Motors" and "Analysis of Starting Characteristics of Direct-Current Motors." At the final session of the convention, which will be held Friday afternooon, there will be presented two papers—"Transient Conditions in Asynchronous Induction Machines and Their Relation to Control" and "Performance of Polyphase Induction Motors Under Unbalanced Secondary Condition."

The National District Heating Association's ninth annual convention at Detroit, June 12-15, promises to be the best yet. A splendid program is being arranged and is given in part as follows: J. D. Hoffman, professor of mechanical engineering of the University of Nebraska, will deliver an address on "A Study of District Heating in the Central West"; Nelson D. Thompson, of the Supervising Architect's office of the Government at Washington, will read a paper on the "Central Heating and Lighting System of the Government Buildings"; Prof. J. R. Allen, of Michigan University, will address the association on some experiments he has been conducting along the line of heating; Halford Erickson, formerly chairman of the Railroad Commission of Wisconsin, will speak on the subject of "Rates and Their Making." In addition to these, there will be reports from the various standing committees, and under a Discussion Session the following subjects will be treated: "Heat Losses from Mains Under Various Conditions," by R. C. March, of Chicago; "Ash- and Coal-Handling Problems," by J. L. Hecht, of Chicago, and G. W. Martin, of New York; "Special Furnace Design and Boiler Insulation" and "Use and Results from Indicating and Testing Instruments in the Boiler Room," by Joseph Harrington, of Chicago; "The Use of the Bonus System in the Boiler Room" will be fully treated by a subcommittee consisting of Messrs. De Wolf, Harrington and Hobbs. Another subcommittee, consisting of Messrs. Vater, De Wolf and Shaw, will carry in their report for this year an extension of last year's work in "Feed-Water Treatment." Recent Station Progress, as illustrated in various new stations, will be covered.

MISCELLANEOUS NEWS

The Water, Light and Power Industry in New York State employed 2 per cent. more workers and paid out 5 per cent. more wages in November than in October, and established a new high record for wages in this industry. As compared with November one year ago, one-twentieth more workers were employed and one-sixth (or 16⅔ per cent) more wages were paid.—New York State Industrial Commission.

Boiler-Code Legislation—It is quite probable that bills will be introduced to adopt the A. S. M. E. Boiler Code at the next meeting of their legislatures in the following states: Texas, Michigan, Minnesota, Kentucky, Illinois, Missouri, Connecticut, Rhode Island, New Jersey, Virginia and Tennessee. Prof. W. M. Kenerson, who attended the meeting of the American Uniform Boiler Law Society in Washington, is now working on a bill in conjunction with the Providence (R. I.) branch of the National Metal Trades Association. Prof. L. S. Randolph and the other delegates from Virginia will actively look after the cause in their state.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points are as follows:

ANTHRACITE

	Circular		Individual	
	Jan. 20, 1917	One Year Ago	Jan. 20, 1917	One YearAgo
Buckwheat	$3.60	$3.10	$6.00@6.50	$3.00@3.50
Rice	3.10	2.50	5.50@5.75	2.60@3.00
Boiler	2.95	....	5.00@5.25	.....
Barley	2.85	2.25	4.20@4.60	2.45@2.60

BITUMINOUS

Prices per gross ton for Boston delivery:

	F.o.b. Mines		Alongside Boston	
	All-Rail Rate $2.60 to Boston		Water Coal	
	Jan. 20, 1917	One Year Ago	Jan. 20, 1917	One YearAgo
Clearfields	$4.75@5.60	$3.00@3.50	$8.00@8.50	$5.90@6.25
Cambrias and Somersets	5.00@6.25	3.00@3.50	8.25@8.75	.....

	F.o.b. Hampton Roads		On Cars, Boston	
	Jan. 20, 1917	One Year Ago	Jan. 20, 1917	One YearAgo
Pocahontas and New River	$6.00@7.00	$2.85@2.90	$9.25@9.50	$6.50@7.00

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports are as follows:

ANTHRACITE

	Circular		Individual	
	Jan 20, 1917	One Year Ago	Jan. 20, 1917	One Year Ago
Buckwheat	$2.75	$2.75	$6.50@7.00	$4.00@4.25
Rice	2.20	2.25	4.50@5.00	3.50@3.75
Barley	1.95	1.75	3.25@3.50	2.75@3.00

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	South Amboy		Port Reading	Mine Price	
	Jan. 20, 1917	One Year Ago	Jan. 20, 1917	Jan. 20, 1917	One Year Ago
Clearfield	$7.00@7.25	$4.15@4.55	$7.00@7.25	$5.00@5.25	$2.75@3.00
South Forks	7.25@7.50	4.30@4.55	7.25@7.50	5.25@5.50	2.75@3.00
Nanty Glo	7.25@7.50	4.30@4.55	7.25@7.50	5.25@5.50	2.75@3.00
Somerset	7.00@7.25	4.15@4.40	7.00@7.25	5.00@5.25	2.50@3.00
Quehamening	7.25@7.50	4.15@4.40	7.25@7.50	5.25@5.50	2.75@3.00

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Jan 20, 1917	One Year Ago	Jan. 20, 1917	One Year Ago
Buckwheat	$2.00	$1.55	$2.90	$2.30
Rice	1.25	.90	2.15	1.80
Boiler	1.10	....	2.00	....
Barley	1.00	.55	1.90	1.30

Birmingham—Current prices per net ton f.o.b. mines:

	Mine-Run	Washed Mine-Run	Washed Nut
Pratt	$3.00	$4.50	$4.50
Big Seam	2.50	$3.75@4.25	$3.75@4.25
Black Creek	$3.00@3.25	4.50	4.50
Carbon Hill	2.50	4.00	4.00
Cahaba	3.50	4.50	4.50

Pittsburgh—Price of steam coal per net ton f.o.b. mine, Pittsburgh district:

	Jan. 20, 1917	One Year Ago
Slack	$3.75@4.00	$1.35@1.60
Mine-run	4.25@4.50	1.40@1.75
¾-in.	4.25@4.50	1.50@1.85

Add 40c. per ton for freight charge to Pittsburgh.

Chicago—Current prices per net ton f.o.b mines:

	Springfield	Clinton and Sullivan Cos.
Steam lump	$3.00@3.50	$2.75@3.50
Egg	3.00@3.50	3.00@3.50
Nut	3.00@3.50	2.75@3.25
Mine-run	3.00@3.50	3.00@3.50
Screenings	2.75@3.50	2.75@3.50

	Williamson and Franklin Counties	Saline and Harrisburg	West Virginia Smokeless
Lump	$3.50@4.00	$3.50@4.00	$4.75@5.25
Egg	3.50@4.00	3.50@4.00	4.75@5.25
Nut	3.50@4.00	3.00@3.50	.....
No. 1 nut	3.50@4.00	.....	.....
No. 2 nut	3.00@3.50	.....	.....
No. 3 nut	3.00@3.50	.....	.....
No. 1 washed	3.50@4.00	.....	.....
No. 2 washed	3.00@3.75	.....	.....
Mine-run	3.00@3.50	3.50@4.00	4.25@4.75
Screenings	3.00@3.50	3.50@3.75	.....

Hocking lump, $3.75@4; split lump, $3.75@4.

St. Louis—Price per net ton f.o.b. mine:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Jan. 20, 1917	One Year Ago	Jan. 20, 1917	One Year Ago	Jan 20, 1917	One Year Ago
6-in. lump	$3.25@3.50	$1.60@1.75	$3.00@3.25	$1.25	$2.50@2.75	$1.10@1.15
2-in. lump	.....	1.35@1.50	.....	1.15@1.25	2.25@2.50	.95@1.00
Steam egg	.....	.....	3.25	.....	3.00@3.25	.....
Mine-run	3.00@3.25	1.10@1.15	3.00@3.25	1.00@1.05	2.25@2.50	.90@ .95
No. 1 nut	.....	1.25@1.35	.....	....	.....	.95@1.00
2-in. screenings	3.00@3.25	.75@ .80	.....	.75@ .80	2.25@2.50	.75@ .80
No. 2 washed	3.25@3.50	1.35@1.50	3.25@3.50	1.35@1.50	.....	1.25@1.40

Williamson-Franklin rate St. Louis, 72½c.; other rates, 57½c.

PROPOSED CONSTRUCTION

Ark., Nashville—The Nashville Ice, Coal and Light Co., Nashville, plans to extend its transmission lines to Mineral Springs.

Ark., Springdale—Springdale Light and Power Co. plans to rebuild its system to include a new power house and lines.

Calif., Arbuckle—The Northern California Power Co. of San Francisco plans a substation in Arbuckle. H. H. Noble, San Francisco, is president.

Calif., Vallejo—Bids will soon be received by the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., for furnishing and delivering under Schedule 617 at Navy Yard, Mare Island, 18 portable ventilating sets.

Calif., Vallejo—Bids will soon be received by the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., for furnishing and delivering at Navy Yard, Mare Island, under Schedule 617, 696 brass petcocks and 336 composition steam and water unions.

Conn., New Haven—Bids will be received by James A. Wetmore, Acting Supervising Architect, Treasury Department, Washington, D. C., until Jan. 31, for the installation complete of three electric elevators in the United States post office at New Haven.

D. C., Washington—Bids will soon be received by the Bureau of Supplies and Accounts, Navy Department, for furnishing and delivering, under Schedule No. 628, at Navy Yards, Mare Island, Calif., and Brooklyn, N. Y., interior communication cable, armored; interior communication cable, leaded and armored; interior communication cable, plain; telephone cable, armored; telephone cable, leaded and armored; telephone cable, plain; interior communication conductors, leaded and armored; single and twin conductors, leaded and armored; single and twin conductors, plain; twin conductors, armored; wire for illuminating outfits.

Ind., Delphi—Carroll County Council plans to install a power plant in the courthouse. E. E. Dunlap, Indianapolis, is the architect. Address County Clerk, Delphi.

Ind., Kokomo—Indiana Railways and Light Co. plans to improve its power plant, including new boilers, turbine, etc. Estimated cost, $148,000.

Kan., Ft. Scott—City Commissioners plan to hold election to vote on $168,000 bonds to install a lighting and heating plant.

Kan., La Crosse—The citizens voted in favor of $12,500 bonds to construct an electric-light plant. W. B. Rollins & Co., 209 Railway Exchange Bldg., Kansas City, Mo., is engineer.

Ky., Manchester—City plans to install an electric-light plant; $25,000 has already been subscribed toward the project. Bond election will also be held.

N. Y., Buffalo—The New York Central R.R. has submitted the plans to the Terminal Commision for a substation at Bond and Clinton St. G. W. Kittredge, New York, is the chief engineer.

N. Y., New York—(Brooklyn)—Bids will soon be received by the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., for furnishing and delivering at Navy Yard, Brooklyn, under Schedule 633, 300 snap switches.

N. Y., New York—(Brooklyn)—Bids will soon be received by the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., for furnishing and delivering at Navy Yard, Brooklyn, under Schedule 610, 2550 brass petcocks, miscellaneous composition pipe fittings, 33 rough brass gate flanged valves and miscellaneous rough brass, screwed, regrinding angle valves.

N. D., Kensal—A. Feckler is interested in a plan to install an electric-light plant in Kensal.

Ohio, Springfield—The Springfield Light, Heat and Power Co. plans to spend $125,000 for improving and extending its plant.

Okla., Kaw City—City voted $10,000 bonds to extend its electric-light plant.

Okla., Osage—The Oklahoma Utilities Co. has been granted a franchise to construct a transmission line in Osage.

Ont., London—The Utilities Commissioners are having plans prepared for an addition to the hydro substation. Estimated cost, $50,000. P. Pocock, City Hall, is chairman.

Ont., Toronto—The Gutta Percha and Rubber Co. plans to extend its power house.

Ore., Astoria—A. G. Spexarth, Astoria, plans to install an electric-light plant in the Spexarth Building.

Penn., Newville—Borough Council plans an electric power plant.

Penn., Philadelphia—Bids will be received by the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., until Feb. 6, for furnishing under Schedule 626, at Navy Yard, Philadelphia, two forced-draft blowers.

Penn., Philadelphia—Bids will soon be received by the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., for furnishing and delivering at Navy Yard, Philadelphia, under Schedule 607, miscellaneous galvanized pipe fittings and galvanized malleable iron unions.

Penn., Tower City—Gratz Electric Co., recently organized, plans a power system to supply service to the western part of Schuylkill County.

Wash., Palouse—The City Council has appointed a committee to investigate the feasibility of granting a franchise to the Washington Water Power Co., Spokane, to install transmission lines and a distributing system in Palouse.

W. Va., Logan—Logan County Light and Power Co. is receiving bids on Jan. 26 for a one-story addition to its power and light plant. Estimated cost $200,000. F. R. Weller, Hibbs Building, Washington, D. C., is the engineer.